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ANIMAL HUSBANDRY
IN INDIA
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CHAPTER I

AGRICULTURAL CONDITIONS

1. Agriculture and climate

THE monsoon of 1938, which set in earlier than usual, was marked by spells of heavy rain which in several places resulted in floods. The total rainfall was above the average in Bihar, the East United Provinces, the Central Provinces, the Deccan, East Madras and Mysore, but defective in North-West India, particularly in the Punjab, Sind and Rajputana. Averaged over the plains of India, the total rainfall during the period was in excess of the normal by 6 per cent. During the retreating period, the rainfall was generally scanty, being defective by 19 per cent over the plains of India. Taking the year as a whole, the rainfall was within 20 per cent of the normal except in the East United Provinces, Berar, the Bombay Deccan and North Hyderabad where it was excessive and in the Punjab, Sind and Rajputana where it was deficient.

Areas under important crops showed some fluctuations during the year. The total area under rice in 1938-39 was reported as 72,943,000 acres as compared with 72,568,000 acres in the preceding year. The out-turn of rice in India for the year 1938-39 was estimated at 23·6 million tons as compared with 26·8 million tons in the preceding year and 27·8 million tons in 1936-37. The crop in 1938-39 was the smallest recorded in the last nine years excepting that of 1935-36 which amounted to 23·2 million tons. The total area under wheat in 1938-39 was reported to be 35,291,000 acres, which was less than the area in the preceding year by 1 per cent. The total estimated yield was 10,114,000 tons, which was 8 per cent less than the yield of 1937-38. The total area reported under sugarcane in 1938-39 was 3,113,000 acres as compared with 3,869,000 acres in the preceding year. The estimated yield amounted to 4,293,000 tons of raw sugar (*gur*), which was less than that of the preceding year by 24 per cent. The crop suffered from drought and excessive rains and flood in places. The total reported area under cotton was 23,507,000 acres in 1938-39 as against 25,746,000 acres in 1937-38. The total estimated out-turn was 5,045,000 bales of 400 lb. each, as compared with 5,722,000 bales in 1937-38, or a decrease of 12 per cent. The out-turn of raw jute during the year was estimated at 6·7 million bales (of 400 lb. each) as compared with 8·7 million bales in 1937-38, or a fall of 2 million bales. The propaganda for the voluntary restriction of jute growing continued throughout the year. The total area under linseed in all the reporting tracts in 1938-39 was 3,894,000 acres as against 3,890,000 acres in the preceding year. The total estimated yield was 469,000 tons as against 461,000 tons last year. The total area under rape and mustard in all the reporting tracts in 1938-39 was 5,508,000 acres as against 5,461,000 acres in the preceding year. The total estimated yield was 969,000 tons as against 1,021,000 tons in the preceding year. The total area under sesamum reported in 1938-39 was 4,331,000 acres as against 4,450,000 acres in the preceding year. The total estimated yield was 459,000 tons as against 465,000 tons in 1937-38. The total area under groundnut in

1938-39 was reported to be 8,439,000 acres, which was less than that of the preceding year by 5 per cent. The total estimated yield was 3,196,000 tons of nuts in shell, as against 3,501,000 tons in the preceding year.

In MADRAS the south-west monsoon was on the whole fairly satisfactory and the sowings of crops favoured by this monsoon were normal or above normal. (The condition of the standing crops in parts of Vizagapatam, Kistna and Tinnevelly was, however, not satisfactory.) As a contrast, the north-east monsoon of 1938 started late in the last week of October and was practically a failure. The rainfall in October was far below normal in all the districts except Vizagapatam which received more than the usual amount of rain. The failure of the north-east monsoon throughout the province resulted in crops withering, the tracts most severely affected being parts of the central districts and the Carnatic. Paddy in Tanjore and Trichinopoly was considerably affected by *soorai* disease owing to drought. The only good feature of the year was that, contrary to expectations, the yield of cotton in the Cuddapah and Kurnool districts was above normal. The area cultivated up to December 1938 was a little less than that of the previous year in the case of both wet and dry crops. The summer rains of 1939 were fairly good in North Arcot, Salem, Vizagapatam and Trichinopoly. Anakapalle was the only research station which had an even distribution of south-west monsoon rains enabling vigorous and healthy growth of paddy and sugarcane crops. The heavy winds of November 1938, however, damaged the sugarcane crop. In the remaining research stations other than Nandyal and Hagari, almost all dry crops failed as a result of the precarious north-east monsoon rains. In Guntur, tobacco planting was partially delayed and the crops planted did not come up satisfactorily. At Kodur, the off-season mango crop was, to some extent, benefited, while the normal season crop of oranges had to be protected by irrigation at the close of 1938. Sugarcane at Gudiyattam and paddy at Pattambi had to be maintained by lift irrigation. The yield of groundnut at Tindivanam was low and the quality was very bad, while the second flush of cotton at Koilpatti was practically a failure. The rainfall recorded at the central farm was the lowest for 33 years and the yield of *chitrai cholam* was the poorest on record. At Nanjanad, the season was favourable for potato but not for *sanai* (*Crotalaria juncea*) or for the growth of fruit trees in the Nilgiris fruit stations.

In BOMBAY, the agricultural season of 1938-39, considering the *kharif* (rainy season) and *rabi* (winter or spring) seasons together, was fairly satisfactory and proved better than its predecessor. The only exception was in North Gujarat where the season proved disappointing. Throughout the season, the rainfall in this area was deficient and the crops were adversely affected. The outstanding feature of the season was the early arrival of the monsoon which strengthened rapidly and resulted in heavy precipitation in the early part of the *kharif* season. As a result, field operations were somewhat hampered and the growth of early sown crops was arrested. Moderate rains with occasional breaks occurred during August and September and facilitated the normal progress of field operations while establishing ideal conditions for the growth of standing crops. At this period, the monsoon conditions gave hopes of a satisfactory harvest. However, the heavy rains which fell at the end of September and in the beginning of October caused considerable damage and had

the effect of reducing considerably the anticipated favourable yields. For the *rabi* crops, however, the late rains proved beneficial, though sowing operations were delayed by about a fortnight. These crops made good progress, but the subsequent absence of favourable rains after October had a somewhat adverse effect. Taking all crops together, there was little alteration in the total area sown during the preceding four years. The area under food grains and groundnut showed a slight increase over the previous year, while the area sown with cotton in 1938-39 decreased compared with the previous year, probably due to the fall in prices.

In BENGAL, in March there was little or no rainfall: in April the rain was defective in the east and north Bengal districts, and very scanty in the Presidency and Burdwan divisions. In May the rainfall was much in excess all through the province. In June, July and August, as a result of incessant and heavy showers, the condition and prospects of crop were seriously affected in north and east Bengal districts, but in the Presidency and Burdwan divisions the fall was generally up to the average. September recorded an average fall except in a few northern and eastern districts where it continued abnormally heavy. In October and November there was no rain in eight districts and normal rainfall in the rest. There was no rain in December and January but in February the province had light showers. With the exception of a few western districts the total rainfall in the province during the period was much in excess of the normal and its uneven distribution combined with sudden floods in a number of districts in the province, Rajshahi, Dacca and Chittagong divisions, did considerable damage.

In the UNITED PROVINCES, unfavourable rainfall, floods and the incidence of red-rot reduced the supply of sugarcane available for *gur* or crushing in factories and the shortage resulted in high prices for sugar and *gur*. The monsoon was irregular and although it started early in June, there were long breaks later on and heavy rains in the east of the province which caused serious floods. In the west and in the centre the monsoon terminated early, resulting in considerable loss to *rabi* crops. Large areas were cultivated in the expectation of a shower just before *rabi* sowings, but this expectation was not fulfilled.

In the PUNJAB, the rains were not favourable for either *kharif* or *rabi* sowings. Following light but general rainfall in April 1938, May was dry. June provided sufficient rain everywhere, but in July and August it was inadequate except in the sub-montane, central and northern districts. September to December were practically dry everywhere. Good rainfall in February, March and early April, however, enabled *rabi* crops to produce yields about normal. The general inadequacy of rainfall caused a decrease in area under most of the principal crops, whilst the yield of wheat was generally normal on irrigated areas and below normal to normal on *barani* (rain-fed) land. The actual fall in the prodnction of baled cotton, as shown by the pressing returns which are furnished under the provisions of the Cotton Ginning and Press Factories Act, 1925, was 7·1 per cent on the crop of the previous year. This figure follows very closely the 8 per cent reduction in area. Nevertheless, the crop was a good one and the total production represented the fifth highest in the history of the cotton crop in the province. The very serious decrease in the area under sugarcane, combined with a yield which was generally below normal, resulted in a drop in the total production of *gur* which was estimated to be 41 per cent

on the previous year's out-turn. Although there was a decrease of 12 per cent in the area under *rabi* oil-seeds, favourable and sufficient winter rains resulted in a crop which was estimated to have given a total production of 4 per cent more than that of the previous year. This summary indicates that because of reduced areas of the principal crops on the one hand and lower rates for most agricultural products on the other, the cultivators of the province as a whole had a less favourable year than the previous one. In the canal colonies, however, the year was not unsatisfactory, for good yields of both wheat and cotton were obtained as a rule, although some damage from rust was reported to late sown wheat, and growers of LSS cotton were disappointed because of the reduction in yield due to drought. The year was much less satisfactory, however, for cultivators in *barani* areas. In the south-eastern Punjab, particularly in Hissar and parts of Rohtak and Gurgaon districts, the failure of the rains caused severe famine which necessitated not only the import of enormous quantities of fodder to keep alive such of the livestock as were not sold off or were not removed to more fortunate areas, but also recourse to test works as a means of providing many of the inhabitants with a source of livelihood.

In the CENTRAL PROVINCES, the monsoon commenced early and was, in general, heavy and continuous, and during the latter part very inopportune. *Kharif* sowings were done under very favourable conditions and germination was satisfactory. The continuous rainfall of July prevented the normal development of *kharif* crops in general. Cotton recovered during August and the prospects were again favourable in September. But the heavy rains of October resulted in a profuse shedding of buds and bolls which caused enormous loss, the full extent of which did not become apparent till late in the season. Anthracnose and mildew appeared in certain places and took additional toll. Heavy rain at the time of flowering interfered to some extent with seed setting in the paddy crop and retarded the development of the grain, but the out-turn was generally satisfactory although the *gangai* disease and hoppers caused some loss in certain localities. *Jowar* (*Andropogon Sorghum*) and groundnut also suffered on account of the continuous and heavy rainfall but not so severely as cotton. The October rains, which damaged *kharif* crops generally, were favourable for *rabi*, and sowing was under ideal conditions. Germination was satisfactory and the crops progressed well till towards the end of November. Absence of winter showers retarded subsequent growth and cloudy weather in January affected the out-turn of linseed. Hailstorms reduced the yield of wheat almost everywhere, particularly in Bilaspur, Drug and certain parts of Jubbulpore and Mandla districts. *Rabi* crops were good in Saugor and Hoshangabad districts but only moderate elsewhere.

In ASSAM, owing to uneven distribution of rainfall, the season, on the whole, was not favourable. Local floods of short duration, droughts and insects also caused some damage to autumn and winter rice crops. In the beginning, the weather for jute was generally fair but afterwards a high flood occurred in the Assam Valley, which damaged the crop severely in certain districts. The weather for *rabi* crops and spring rice was not quite satisfactory due to drought at sowing time. Insects too caused some damage. Cultivation of rice, rape, mustard and jute increased, while there was a slight decrease under sugarcane and tea in comparison with the previous year. The average yield per acre of all crops showed a slight decrease as compared with that of the previous year.

Prices of agricultural produce generally showed a gradual improvement as compared with that of last year.

In HYDERABAD, in Telingana, the monsoon arrived rather early and the total rainfall in the *kharif* season was more than usual. Continuous rain with heavy showers after the sowing of the crop damaged it considerably. The sowing of the *rabi* crop was delayed due to heavy showers in September and October. There was no substantial rainfall subsequently. The *rabi* crop could not make satisfactory growth, excepting in the irrigated areas. In Marthwara, the monsoon started well and at the right time, but its distribution was very uneven and many crops, particularly cotton, suffered through excess of moisture. Good showers were received in September and October which helped in the timely sowing of the *rabi* crop, but it suffered for want of moisture in the absence of rain afterwards. The Raichur district in the Karnatak was more fortunate than other districts. The monsoon started early and it was well distributed in this district, yielding a good *kharif* harvest. In other districts, the rainfall was torrential and ill-distributed. This did not allow of interculture of the *kharif* crop and proper preparation for the *rabi*. Heavy showers were received in September, which proved favourable for sowing the *rabi*, but the crop suffered from want of moisture afterwards.

In MYSORE, the rainfall was insufficient and unevenly distributed and the seasonal conditions were not quite satisfactory for agriculture during the year. This affected paddy cultivation in tanks in Mysore and Hassan districts. The failure of *mungar* rains affected the yield of dry crops in Mandya, Mysore and Hassan districts. The unfavourable rainfall in the Shimoga district adversely affected paddy, its main crop. The low rain-fall of the north-east monsoon affected the yield of cotton in the Chitaldrug district and of *ragi* in the Kolar district. There was slight scarcity of fodder and water. While the prices of *ragi* and paddy were satisfactory and the price of *gur* rose considerably, the plantation crops—coffee, cardamom and areca—fetched very low prices and the economic condition of estates and gardens deteriorated seriously.

In BARODA, the monsoon broke exceptionally early in the first week in June. The rainfall from then to the end of July was heavy. This was followed by a dry August (apart from some useful rain in Mehsana) and a very dry September, particularly in the Baroda district. The situation was in part saved by some rain in early October. The Amreli district was the worst hit, in particular Amreli, Dhari and Khambha talukas and a certain area in Mehsana fared none too well. The heavy early rain led to a poor stand. Paddy in all districts was badly damaged, unless protected, while groundnut and *bajra* (*Pennisetum typhoideum*) suffered, in particular in the Northern Circle. Cotton, however, in both the southern districts due to good rainfall in October followed by mild winter yielded above the average. In Mehsana the yield was about the same as in 1937-38. In Amreli it was much below average. The character of the season had a serious effect on many of the field experiments, in particular at Amreli and Jagudan farms and in a number of village demonstration plots, specially those associated with paddy. The comparati e tests in progress failed to give conclusive results.

In TRAVANCORE, weather conditions during the year under report were erratic. The total precipitation at most of the stations was more than that of the previous year. But it was considerably less than the normal. Both the

south-west monsoon and the north-east monsoon were late and scanty in South Travancore. *Consequently the paddy crop was affected adversely. The spell of hot weather was unduly long in* North Travancore. Coconut and areca nut palms suffered badly. In some places, many areca palms were killed by the long drought. In Central Travancore, excepting in the Shencottah taluka, rainfall was copious. The seasonal conditions, on the whole, were unfavourable to paddy, arecanut and coconut.

In COCHIN, the south-west monsoon commenced in time with normal vigour but towards the close of the period the rainfall was scanty. Viruppa paddy of long-duration type therefore suffered from severe drought. The north-east monsoon was much below the average throughout the state and caused damage to the second crop. The Talapilly and Chittur talukas and certain areas in the Trichur taluka suffered the most. The eastern wind commenced in time. The south-west monsoon commenced with a fall of 4·8 in. of rain in a day. The paddy crop was uniformly good in most of the areas, but the harvest of all short-duration types of paddy had to be harvested in heavy rains with the consequent loss of both grain and straw. Crops of the type of bananas, root crops and vegetables fared well.

2. Economic conditions

The depression in the price of agricultural prices which started in the latter part of 1937 continued during most months of the year. In 1938-39 there was only one period when this downward trend in commodity prices was arrested and slightly reversed. This was in June 1938 when conditions in America appeared to have taken a turn for the better. The upward swing lasted only for a few months as the European political crisis, which gathered force in September, arrested this incipient recovery. As a result, the prices of many commodities resumed their downward march. Prices of many of India's staple articles continued on a low level after the sharp fall in the latter part of 1937-38.

Prices of raw cotton moved within a narrow range in the year under review as compared with the rapid downward trend in the previous year. The average level of prices was, however, lower in 1938-39 than in 1937-38, and the trend, apart from temporary fluctuations, was generally downwards. The statistical position of Indian cotton was comparatively favourable as the crop was relatively short and less than the estimated consumption. The carry-over from the preceding year was, however, large and this, added to the world causes, depressed the prices of Indian cotton during the year. The level reached was the lowest for many years past. The quotation for M. G. F. G. Broach per candy of 784 lb. was Rs. 165 at Bombay at the end of March 1938.

Raw jute had a remarkable recovery and prices at the end of March 1939 had attained to heights untouched for many years past. The main causes of this great improvement were, firstly, the Bengal Government Ordinance promulgated in September 1938, restricting the hours of work in the jute mill industry, followed by the conclusion of the agreement in January 1939, by which the mills agreed voluntarily to restrict working hours and regulate production. These developments materially improved the prospects of the mill industry and naturally meant more favourable conditions for the raw jute trade. Coupled with this was the expected increase in the demand for jute manufac-

tures, especially for sandbags from the United Kingdom and from other countries for war preparations. This improved demand for Indian jute manufactures was naturally passed ou to raw jute. The other important cause of the remarkable rise in raw jute prices was the short crop in the 1938-39 season. In the last three months of 1938-39 prices of raw jute rose rapidly, the quotation at the end of March being Rs. 46. This level had not been reached in the last eight or nine years.

A Jute Enquiry Committee was appointed in 1939 to consider, among other things, the possibility of introducing compulsory restriction of jute growing and the cognate qnestion of a minimum price for raw jute.

Prices of oil-seeds on the whole declined very considerably during the year. By the end of 1938, prices in the case of many oil-seeds had reached levels which were hardly remunerative to the producers. The best that could be said about the prospects of the oil-seeds markets was that supplies did not exceed the demand. Supplies of most oil-seeds were plentiful during the year and consumption was adversely affected by political and economic conditions. Conditions in the groundnut markets were decidedly depressed during the year. The two main causes were the general recession in the world's oil-seeds markets and the bumper groundnut crop in India which came into the market in 1938. Exports of groundnuts during 1938-39 amounted to 835,000 tons as compared with 619,000 tons in the previous year or an increase of 35 per cent. Exports of linseed from India during the year amounted to 318,000 tons as compared with 227,000 tons in 1937-38 or an increase of 91,000 tons. Throughout the year India was a seller of linseed at competitive rates. The exports of Indian linseed were helped by the comparatively short supplies from the Argentine.

An important development in India regarding wheat was the reintroduction of the protective duty on imports of wheat from December 1938. The duty was first levied in 1931 and was then continued at varying rates for several years. It was not reimposed in 1937-38 because in that year India was in the position of a wheat exporting country rather than an importing one. In the first half of the year India exported considerable quantities of wheat, but the record world crop of 1938 which came into the market from September onwards changed the whole situation and, instead of exporting, India began to import wheat as from October. The imports continued even after the imposition of the duty and the total imports in the year under review, almost the whole of which came after October, amounted to 159,000 tons as compared with 22,000 tons in the preceding year.

Most of the rice imports come from Burma which generally has a large exportable surplus. India imported 1,281,000 tons of rice from Burma valued at Rs. 11,36 lakhs, as compared with 1,198,000 tons valued at Rs. 10,98 lakhs in the preceding year. The increase in imports was due to the heavy receipts of rice from Burma in the last three months of the financial year 1938-39, i.e. from January to March 1939. Imports during the first nine months of the year, i.e. till the end of December 1938 were 151,000 tons less than in the corresponding period of the preceding year. In other words, imports into India from Burma in the first quarter of 1939 exceeded those in the same quarter of 1938 by 234,000 tons, amounting to the large figure of 525,000 tons. The main cause of these heavy imports after the close of 1938 was the unusually

short crop in India. Prices of rice have been remarkably steady during the last three years.

Imports of manufactured tobacco showed a slight decline in quantity from 6·6 million lb. in 1937-38 to 6·4 million lb. in 1938-39; but due to smaller receipts from Burma of cheaper materials, rose in value from Rs. 45 lakhs to Rs. 58 lakhs. Imports from the United States of America totalled 3·3 million lb. valued at Rs. 46 lakhs in the year under review and those from the United Kingdom, representing mainly the re-exports of American leaf tobacco, to about 1 million lb. valued at Rs. 9 lakhs. Imports of foreign cigarettes advanced from 993,000 lb. valued at Rs. 34 lakhs in the preceding year to 1,218,000 lb. valued at Rs. 40 lakhs in 1938-39. As usual, the United Kingdom was the largest supplier and her share amounted to 1,167,000 lb. or 96 per cent.

3. Imperial Council of Agricultural Research

With effect from 15th January 1939 the Secretariat of the Council ceased to be a Department of the Government of India, connection therewith is now maintained through the Department of Education, Health and Lands. The designations of the Agricultural Expert and Animal Husbandry Expert were changed to Agricultural Commissioner with the Government of India and Animal Husbandry Commissioner with the Government of India, respectively.

The Advisory Board and the Governing Body of the Council met once during the year. The Annual General Meeting of the Council was held in November 1938, when the annual reports on the working of the Council and on the accounts of the Council for 1937-38 were adopted. The usual standing committees and the *ad hoc* committees met to discuss the progress of research in different crops and animal husbandry schemes, and to make plans for further investigations. The number of new schemes approved by the Governing Body was 15 and the total funds allotted for research at the end of 1938-39 was Rs. 93,84,500. A complete list of schemes financed by the Council is given in Appendix XVI.

An outstanding event of the year was the third meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry which was held in New Delhi in February 1939. The Conference was opened by the Hon'ble Kunwar Sir Jagdish Prasad, K.C.S.I., C.I.E., O.B.E., late Member of His Excellency the Viceroy's Executive Council, in charge of the Department of Education, Health and Lands, and was attended by a large number of official and non-official representatives of different provinces. Mr M. Crawford, Deputy Director of Agriculture, Ceylon, attended the meeting on special invitation. The discussion embraced several important matters, such as animal diseases, mixed farming, fodder and grazing, animal nutrition and dairying. The full report of the meeting has been published separately by the Council.

Among other activities of the Council may be mentioned an enquiry into the agricultural and veterinary needs of Coorg with a view to developing the resources of this small but important tract. Mr A. K. Yegnanarayana Aiyar, retired Director of Agriculture, Mysore, was entrusted with the task. The enquiry lasted for about six months. Mr Aiyar's report was considered by the Council and steps are being taken to translate some of the recommendations into practice.

An enquiry was undertaken into the possibilities of extending the cultivation of cinchona in India and Mr Wilson, Deputy Director of Agriculture, Madras, was deputed for the purpose. The report has since been written and a scheme to implement the recommendations made in the report is under consideration.

The Council arranged to obtain seeds of pyrethrum through the Director of the Plant Pathological Laboratory, Harpenden, England. Experiments were laid out in various areas to find out whether its cultivation was an economic possibility. Reports received indicate that it can grow successfully in certain hilly tracts at elevations of 4,000 to 7,000 ft. Fresh consignments of seed were obtained from Dalmatia (Yugoslavia), for further experiments in centres where it had already grown successfully.

Among schemes financed by the Council those on rice occupy an important place. The schemes relating to the United Provinces, the Central Provinces and Berar and Assam were renewed for further periods. A scheme for rice research in Kashmir was approved as a part of the coordinated group of schemes.

Methods of controlling wheat rust (based on the work of Dr K. C. Mehta) were under consideration.

A special sub-committee of the Board examined the question of the presentation of horticultural data in field experiments and prepared standard forms to be adopted by horticultural stations. A cooperative experiment on the behaviour of certain well-known citrus fruit stocks under different climatic conditions has been undertaken and the provinces selected for this trial are the Punjab, the Central Provinces and Berar, Assam and Orissa.

The Council contributed towards an expedition organized by the Imperial Agricultural Bureaux to South and Central America to collect species of *Solanum*. The expedition has since returned and the material collected has been received. Necessary additional equipment for receiving and handling the material are being provided in the Potato Research Station, Simla.

The Council sanctioned the deputation of an Indian worker to America to study tobacco cultivation and processing in that country. Mr C. V. S. Chetty, who was selected, has since returned. Two more officers from Bombay and Bihar have been appointed for similar training and as a preliminary step accompanied Mr Chetty in his tours in India.

Research on medicinal plants has resulted in the discovery of 700 poisonous plants. The botanical, chemical and pharmacological aspects of these plants, which have been investigated with the help of the Indian Research Fund Association and the School of Tropical Medicine, will be described in a book shortly to be published.

The examination of the old locust data was completed during the year. Much of the time was devoted to a study of the correlation of the meteorological and locust data for the past locust cycles. Much attention was also devoted to the compiling and studying of the data collected in the course of the locust research work carried out since 1931, preliminary to writing up a consolidated account of the results obtained.

The Statistical Section continued its main activities of scrutinizing the technical programmes and progress reports of the schemes sanctioned by the Council.

The need for evolving a system of description of crop-plant characters by which workers in different parts of the country could compare their varieties was felt and the Advisory Board appointed two committees, one on cotton and the other on rice, to prepare schedules for this purpose. The reports prepared by these two committees were published by the Council in the *Indian Journal of Agricultural Science.* This new method has much to commend itself and has received universal approbation. It is proposed to pursue it in the case of wheat and other crops.

Another important feature of the year was the Conference of Ministers on Agricultural Marketing opened by H. E. the Viceroy in New Delhi on 29th November 1938. The main object of the conference was to review the work carried out so far by the Marketing Branch and to lay down future lines of work. As a result of recommendations made by this conference, the Central Marketing Staff is considering the scope of central legislation for controlling commodity exchanges dealing in futures with a view to the elimination of *satta* (gambling) transactions. Among other activities of the Marketing Branch, mention may be made of the arrangements made for the daily broadcast from Delhi of 'ready' and 'futures' prices in Hapur market for a number of cereals, pulses and oilseeds. In addition, a weekly market report in English and Hindustani is broadcast every Saturday and issued to over 100 newspapers. This includes a summary of the position in markets abroad as received from the Indian Trade Commissioner in London. Attempts were made to maintain closer relations between marketing staffs and the commercial branches of the railways, and as a result of discussion with the local marketing staffs, several railways have allowed more than 100 concessional rates on about 30 different commodities. The Standards of Weight Act was passed in 1939 for standardizing the weights on an All-India basis. The number of grading stations is rapidly increasing. The results show that there is, in fact, a good demand among consumers for reliable high-grade produce for which producers can secure a substantial premium. In some cases the products were sold for 50 per cent more than similar ungraded produce and the average increase ranged from 5 per cent in the case of eggs to 9 per cent for fruit and 12 per cent for ghee. The Central Marketing Staff circulated a model bill for the regulation of markets and before the end of March 1939 an Act for that purpose had been passed in the Punjab. Bills suitable for local conditions were prepared or introduced in the United Provinces, Bihar and Bengal and were under preparation in Sind, North-West Frontier Province, Mysore and Travancore. The Bombay Act was being amended to include produce other than cotton, and in Madras the Commercial Crops Markets Act was extended to tobacco in Guntur district and groundnuts in South Arcot. The Railway Board, in collaboration with the Imperial Council of Agricultural Research and the Defence Department, introduced an experimental railway refrigerated van and the Agricultural Marketing Adviser carried out test runs of the van with fruits and vegetables. The prices obtained for the produce showed possibilities inherent in this form of transport.

A steady uniform improvement was maintained in respect of the various animal husbandry schemes operating under the auspices of the Council. The research and developmental problems include, *inter alia*, the improvement of goats, sheep and poultry, and investigations are also being carried out at various centres into a number of animal nutrition problems peculiar to this country.

In regard to poultry, the fact that under the present circumstances in India research into the diseases was more important than poultry breeding, has lead to the submission of a number of schemes by various provinces for the appointment of an additional officer in each province and constituent state for research into the diseases of poultry. The establishment of such an organization all over the country will materially benefit the industry and it will also be possible to take full advantage of the specialist officer appointed for research on poultry diseases at the Imperial Veterinary Research Institute, Izatnagar.

The importance of detailed investigation into the efficacy of indigenous drugs and their possible utilization on a much larger scale has, of late, attracted considerable attention. The question has, therefore, been under consideration for some time past and a Madras scheme for research into the indigenous drugs of India with special reference to their toxicology was sanctioned in December 1937. The programme of work provides for: (1) a scientific study of indigenous drugs of reputed efficiency and poisonous plants and, in the case of those likely to prove of therapeutic use in veterinary practice, assessment of their value and standardization of the dose for large animals; and (2) examination of the pharmacopoeial drugs and their allied species growing in India which are used in veterinary practice, in order to ascertain the possibility of employing them in place of imported drugs.

Another scheme relates to the investigation into the efficacy or otherwise of the indigenous system of treatment of cattle in this country. An officer has been appointed for this purpose and his report is awaited.

The economic and scientific importance of rinderpest, which is known to be responsible for 60 per cent of the total annual mortality of cattle from contagious disease in India, has been appreciated fully in recent years. With the object of testing the efficacy of the new goat-virus method of vaccination against this disease, a scheme was sanctioned by the Council in 1934 which terminated in March 1938. Apart from the large amount of valuable scientific data collected as a result of this scheme, it was possible to carry out mass inoculation of cattle in certain areas in the Central Provinces and altogether in three years as many as 382,621 animals were inoculated with very satisfactory results. The immunity in these animals is expected to last at least for four to five years. Another great advantage is that this method of vaccination is now popular among the local people and cattle dealers and has considerably facilitated the working of the Cattle Diseases Act in the Central Provinces.

The research on warble flies which are responsible for great damage to hides and skins of cattle and goats, has disclosed that the North-West Frontier Province and the Punjab are the most heavily infested provinces, while the pest is fairly common in the United Provinces and has also been noticed in the hilly tracts of Bengal. Areas with little or no rainfall after the winter months seem to be well suited for the safe completion of the parasite's life-cycle. An attempt is now being made to draw up a calendar showing the seasonal occurrence of this pest in different localities in India.

Appreciable progress has been made in some provinces in the formation of milk-recording societies with a view to assisting the development of the high milk-yielding strains of the more important Indian breeds of cattle. The scheme is in progress in the Punjab, Bombay, the United Provinces and Madras. The Sind Government are also shortly expected to participate in the scheme.

As a preliminary step in the establishment of herd books for seven breeds of milch cattle of all-India importance, steps have been taken by the Council to define their breed characteristics and an important publication, which should be of considerable interest to cattle breeders in this country, entitled *Definition of Characteristics of Seven Breeds of Cattle of All-India Importance*, Miscellaneous Bulletin No. 27, has been issued. Another important publication which merits special mention is *Milk Records of Cattle in Approved Dairy Farms in India*, Miscellaneous Bulletin No. 18. It contains records of lactations completed during 1936-37 by milk stock in dairy farms in India. This is the first publication of its kind and contains information regarding the milking potentialities of a number of breeds of Indian cattle and buffaloes. This series is being continued and the compilation of the second instalment comprising records for 1937-38 is now in hand.

The Council awarded two scholarships for training overseas in animal genetics, and tuberculosis and Johne's disease in animals. The selected candidates are now undergoing training in the United Kingdom.

CHAPTER II

ECONOMIC WORK ON CROPS*

THE ascertained area under improved varieties of crops in British India in 1938-39 was 23·81 million acres as compared with 22·05 million acres in 1937-38. These figures by no means represent the whole extent to which improved strains have replaced old varieties as it is difficult to gauge the full extent of the natural spread of improved varieties.† Tables I and II show the position so far as it can be ascertained.

* The assistance of the following officers in the preparation of this chapter is gratefully acknowledged :—

(1) Mr C. R. Srinivasan, Paddy Specialist, Agricultural Research Institute, Coimbatore	*Rice.*
(2) Dr B. P. Pal, M.A., Ph.D. (Cantab.), F.L.S., Imperial Economic Botanist, Imperial Agricultural Research Institute, New Delhi	*Wheat and Potatoes.*
(3) Mr D. N. Mahta, B.A. (Oxon.), Secretary, Indian Central Cotton Committee, Bombay	*Cotton.*
(4) Rao Bahadur T. S. Venkatraman, C.I.E., I.A.S., Government Sugarcane Expert, Coimbatore	*Sugarcane.*
(5) Mr C. R. Nodder, M.A. (Cantab.), Late Secretary, Indian Central Jute Committee, Calcutta	*Jute.*
(6) Khan Sahib Ali Mohammad, M.Sc. (Agri.), Botanist for Oilseeds, Punjab Agricultural College, Lyallpur	*Oil-seeds.*
(7) Mr P. H. Carpenter, F.I.C., Director, Scientific Department, Indian Tea Association, Cinnamara, Assam	*Tea.*
(8) Mr M. J. Simon, Secretary, Indian Coffee Cess Committee, Bangalore	*Coffee.*
(9) Dr G. S. Cheema, D.Sc., I.A.S., Horticulturist to Government, Bombay Province, Poona	*Fruits.*
(10) Professor L. S. S. Kumar, M.Sc., A.R.C.S.I., D.I.C., Economic Botanist to the Government of Bombay, Poona.	*Fodder Crops and Grasses.*
(11) Mr B. S. Sawhney, B.A. (Cantab.), Botanist for Millets, Botanical Sub-station, Sirsa, Punjab	*Millets, Beans and Pulses.*
(12) Rao Sahib Ram Dhan Singh, Cereal Specialist, Punjab Agricultural College, Lyallpur	*Other Cereals.*

† The present method of calculating returns on the natural spread, i.e. the area under seed distributed by ryots from previous crop for which seed was made available by the Agricultural Departments is far from satisfactory and needs considerable improvement. The data supplied are useful, however, in giving a rough indication of the extent of expansion of area under improved crops.

TABLE I

Areas under improved crops in India during 1938-39 (in acres) as far as information is available

Province or State	*Rice*	*Wheat*	*Cotton*	*Sugarcane*	*Jute*
			BRITISH INDIA		
Madras	1,704,399	51	627,334	54,516	..
Bombay	65,419	314,217	990,604	44,741	..
Bengal	603,984	4,386	216	252,374	1,571,534
United Provinces	312,485	647,873	29,904	985,069	516
Punjab	237,800	4,922,900	2,510,800	227,000	..
Bihar	42,698	79,083	..	410,525	..
C. P. & Berar	781,040	606,319	300,380	17,902	..
Assam	51,199	..	..	15,449	14,884
N.-W. F. P.	..	439,025	5,054	46,237	..
Orissa	22,323	293	235	33,500	424
Sind	540,876	781,396	1,690,044	5,614	690
Baluchistan	213	7,455	1,280	2	..
Coorg	35	..	..	..	..
Total for British India	4,362,471	7,802,998	6,155,851	2,092,929	1,588,048

Province or State	*Millets*	*Gram*	*Potatoes*	Ground-nut	Other crops
			BRITISH INDIA		
Madras	244,035	..	14,592	35,011	9,258
Bombay	102,605	75	2,310	53,212	88,493
Bengal	727	2,268	4,395	2,941	48,625
United Provinces	8,650	68,577	367	6,184	159,586
Punjab	47,200	103,500	15,200	29,300	49,800
Bihar	..	8,986	..	1,151	10,626
C. P. & Berar	..	..	..	184,236	280,267
Assam	..	..	12,497	..	..
N.-W. F. P.	..	..	2,816	1	5,680
Orissa	45	350	3,550	5,550	13,761
Sind	23	14,652	28	..	175,789
Baluchistan	174	..	..	..	16
Coorg	..	..	2	1	..
Total for British India	403,459	198,408	55,757	317,587	841,901

TABLE I—*concld.*

Province or State	Rice	Wheat	Cotton	Sugarcane	Jute
			INDIAN STATES		
Hyderabad	6,613	4,463	188,095	15,253	..
Mysore	95,457	14	39,042	5,407	..
Baroda	8,792	14,375	105,749	756	..
Travancore	218	..	..	..	..
Cochin	534	..	10,000	358	..
Bhopal	23	75,827	288	6,815	..
Kashmir*	1,995	541	10	13	..
Total for Indian States	113,632	95,220	343,184	28,602	..
Grand Total for British India and Indian States.	4,476,103	7,898,218	6,499,035	2,121,531	1,588,048

Province or State	Millets	Gram	Potatoes	Ground-nut	Other crops
			INDIAN STATES		
Hyderabad	3,050	..	..	198,961	587
Mysore	205,249	301	424	47,936	20,377
Baroda	3,341	..	..	196	..
Travancore	..	..	..	..	..
Cochin	..	..	..	75	240
Bhopal	..	4,078	..	3,705	1,880
Kashmir*	..	..	..	..	1,598
Total for Indian States	211,640	4,379	424	250,873	24,682
Grand Total for British India and Indian States.	615,099	202,787	56,181	568,460	866,583

* Departmental seed 4, 160·25 acres under different crops. Natural spread not known.

TABLE II

Areas under improved crops in India (as far as information is available)

Crops	British India		Indian States		Grand Total for British India and Indian States	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
Rice	3,696,806	4,362,471	62,141	113,632	3,758,947	4,476,103
Wheat	6,833,051	7,802,998	97,017	95,220	6,930,068	7,898,218
Cotton	5,301,904	6,155,851	369,655	343,184	5,671,559	6,499,035
Sugarcane	2,833,606	2,092,929	21,773	28,602	2,855,379	2,121,531
Jute	1,781,096	1,588,048	..	..	1,781,096	1,588,048
Millets	186,762	403,459	160,438	211,640	347,200	615,099
Gram	80,162	198,408	3,600	4,379	83,762	202,787
Potatoes	20,990	55,757	6	424	20,996	56,181
Groundnut	215,537	317,587	201,905	250,873	417,442	568,640
Other crops	1,105,636	841,901	4,005	24,682	1,109,641	866,583
TOTAL	22,055,550	23,819,409	920,540	1,072,636	22,976,090	24,892,225

1. Rice

The rice crop occupies, on an average, about 35 per cent of the total cultivated area in India. A review of the estimated area and production of rice for the quinquennium ending 1938-39, reproduced below, shows that during this period the production has decreased by 10·8 per cent, in spite of the slight increase in area.

TABLE III

Acreage and production of rice during the quinquennium ending 1938-39

Year	Area in acres (thousands)	Yield in tons (thousands)	Average yield per acre (in pounds)
1934-35	69,731	25,706	826
1935-36	70,998	25,213	732
1936-37	72,295	27,826	862
1937-38	72,568	26,702	826
1938-39	72,574	23,577	728

Although India is a large rice-producing country, she has still to import considerable quantities of rice, chiefly from Burma. In the year under review, owing to the unusual short crop, imports from Burma amounted to 1,281,000 tons of rice valued at Rs. 1,136 lakhs, as compared to 1,198,000 tons valued at Rs. 1,098 lakhs in the preceding year. The total out-turn of rice in India, together with exports from and imports into India during the past five years, is as follows :

TABLE IV

Production and export from and imports into India of rice during the quinquennium ending 1938-39

Year	Production (thousand tons)	Export from India (thousand tons)		Import into India (thousand tons)	
		Rice	Paddy	Rice	Paddy
1934-35	25,706	204	4	2,504	*
1935-36	23,213	189	4	1,391	252
1936-37	27,828	235	1	1,419	121
1937-38	26,702	227	1	1,198	36
1938-39	23,818	282	3	1,282	84

* Figures for paddy are included under rice.

In this connection a review of the figures of import of rice from Burma to India, as recorded in the *Burma Trade Returns* for the different periods during the past three decades, is an interesting study by itself. They are reproduced below.

TABLE V

Comparative figures of imports of rice and pulses into India from Burma during the past three decades

(In thousand tons)

Period	Rice in husk	Rice not in husk	Pulses	Gram
Pre-war average	214	383	19	5
War average	168	806	19	1
Post-war average	93	709	46	15
1936-37	87	15·34	·82	30
1937-38	50	1,267	39	6
1938-39	96	1,475	60	10

It will be seen that imports of rice in the husk declined considerably after the war, while imports of rice not in the husk and pulses in the past few years have doubled, when compared to the war and post-war averages.

During the year, there was a slight improvement in the export of rice, chiefly destined to Ceylon, Arabia and African territories having a large Indian population. Table VI below shows the direction of the export trade for the three years ending 1939.

TABLE VI

Export of rice to foreign countries

(In thousand tons)

Countries	1936-37	1937-38	1938-39
United Kingdom	8	6	6
Rest of Europe	10	7	4
Ceylon	84	91	105
Rest of Asia	69	62	81
Union of South Africa	23	23	25
East Africa	6	6	6
Other countries	30	32	55

Rice is not a commercial crop of India, nearly 60 per cent of it being retained by the growers themselves for consumption, and the remaining 40 per cent alone finding its way into the wholesale markets. Price movements in India are very largely affected by the price changes in Burma. A general increase in price prevailed till October, reaching Rs. 4-4 per maund. Thereafter it declined to Rs. 3-12 in January 1939. In the last two months of the year, the price was more or less steady at about Rs. 4.

The IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH continued to finance a group of coordinated schemes of research in rice to ensure more adequate attention to this important crop covering 72 million acres and to secure a better inter-change of information and material between the workers in the different provinces. The question of the reconstitution of the Standing Rice Committee for a further period of two years was considered and recommended. During its sittings, progress reports of the schemes from states and provinces were scrutinized and recommended by the appropriate sub-committees. Schemes relating to the United Provinces, the Central Provinces and Assam were extended for further periods. A new scheme for rice research in Kashmir was approved and the sanction of funds is awaited.

The total area and production under rice in the different provinces and states in India compared with the preceding five year average are set forth in Tables VII and VIII. It will be seen that the major rice provinces, barring the United and the Central Provinces, have recorded during the year a decrease both in acreage and out-turn as compared to the five-year average. The acre-yields in almost all the provinces as compared to the previous year are also low.

TABLE VII

Area of rice in each province

Provinces and States	Percentage of the area to the total area under rice	Area in acres (thousands) 1938-39	Area in acres (thousands) Average of preceding 5 years	Increase (+) or decrease (—) in the current year over the average of preceding 5 years
Bengal	28·7	21,974	21,455	+2·4
Madras	14·5	9,943	10,796	—7·9
Bihar	13·2	9,580	9,868	—2·9
Central Provinces (*a*)	9·8	7,824	7,308	+7·1
United Provinces (*b*)	8·9	7,621	6,413	+18·8
Orissa	6·8	5,138	5,163	—0·5
Assam	6·8	5,034	4,967	+1·3
Bombay (*c*)	3·3	2,339	2,410	—2·9
Sind (*d*)	1·5	1,193	1,139	+4·7
Hyderabad	1·5	884	1,137	—22·3
Baroda	0·3	197	213	—7·5
Mysore	1·0	732	738	—0·8
Bhopal	..	31	25	+24
Coorg	..	84	84	*nil.*
TOTAL	100·0	72,574	71,716	+1·2

(*a*) Includes Eastern Agency States formerly Central Provinces.

(*b*) Includes figures for Rampur State.

(*c*) Includes Indian States.

(*d*) Includes Khairpur State.

TABLE VIII

Yield of rice in each province

Provinces and States	Yield in tons (thousands)		Increase (+) or decrease (—) during 1938-39 over average of preceding 5 years	Average yield per acre in lb.	
	1938-39	Average of preceding 5 years		1938-39	1937-38
Bengal	7,567	8,666	—12	771	911
Madras	4,057	5,047	—19·6	914	1,071
Bihar	2,654	3,104	—14·5	621	704
Central Provinces (*a*)	2,263	2,091	+8·2	648	599
United Provinces (*b*)	1,982	1,782	+11·2	583	641
Orissa	1,406	1,448	—2·9	613	697
Assam	1,587	1,620	—2·0	706	778
Bombay (*c*)	949	1,048	—9·4	909	987
Sind (*d*)	484	438	+10·5	909	973
Hyderabad	321	353	—9·1	813	857
Mysore	201	220	—8·6	613	700
Baroda	40	55	—27·3	455	436
Bhopal	10	8	+25·0	723	695
Coorg	56	54	+3·7	1,493	1,449
TOTAL	23,557	25,934	—9·1	728	826

(*a*) Includes Eastern Agency States, formerly Central Provinces.
(*b*) Includes figures for the Rampur State.
(*c*) Includes small Indian States.
(*d*) Includes Khairpur State.

Research in all the provinces is therefore primarily directed towards the problem of increasing the out-turn per acre, by breeding high-yielding varieties and improving the manurial and agricultural practices.

The recommendation of the Royal Commission on Agriculture to accelerate the programme of breeding and the spread of improved strains of rice has been receiving the attention of the Provincial Departments of Agriculture. A large number of strains of merit suitable to varied conditions of cultivation and climate are already in distribution. It is reported that in many areas the spread of the strains is so rapid that it is difficult to trace their course, making it difficult to estimate the area under them.

A brief summary of the work in the different provinces is given below.

The improvement of the varieties of rice grown in BENGAL is in charge of the Economic Botanist and is carried on at the four main research stations at Dacca, Barisal, Chinsura and Bankura. At the Dacca farm, research on the high-land *aus* (autumn) and transplanted and broadcasted *aman* (winter) paddy was continued. Nine-hundred and twenty-five pure lines in *aus* varieties were under study to evolve an early high-yielding *aus* paddy. Six-hundred and ninety-three cultures of medium deep-water paddies were studied and classified into two groups, one to withstand 3-4 ft. depth and the other to withstand 7-8 ft. depth of water.

The study on the effect of dusting rice plants with larvicides was continued for another season and confirms the findings of the previous year, that dusting the rice crop with Paris green does positively reduce the yield of grain and straw. In a factorial experiment, on five dates of planting, six ages of seedlings and three different number of seedlings per hole, it was observed that the yield deteriorates with successive dates of planting and that there was not significant difference between the different ages of seedlings. But there was, however, a necessity to increase the number of seedlings per hole with later plantings. In another experiment with different spacings and three varieties, early and closer plantings, irrespective of the varieties, contributed to higher yields. At Chinsura, the results of a complex experiment for the fifth year showed that the first planting (16th July) gave the highest yield. The experiment on ages of seedlings and dates of planting showed that higher yields were obtained in the first planting irrespective of the age of seedlings. Pure-line cultures, numbering 1690 and 952, were established at Chinsura and Bankura respectively. Nona Ramsail alone maintained its merit in Situation II. In the other situation, the best of the previous year did not come up to expectation.

The rice improvement work in MADRAS is carried out at Coimbatore, the chief centre of research, and at sub-stations at Aduturai for the Cauvery delta; Maruteru for the deltas of Godavary and Kistna, and at Pattamhi for the West Coast districts. Testing stations, two in number, were recently opened to meet the needs of two minor irrigation systems, viz. the Bennar and the Tamparabarani.

During the year, three strains (Ptb 11—Halliga, Adt 18—Vellaikuruvai and Adt 19—Sarapalli, yielding 30, 12·5 and 19 per cent respectively over the corresponding ryots' bulk) were released for distribution. Prior to release, cultures 5109 in Arupathamkodai, 1303 in Chitteni of Malabar and 3156 in Atragada of Godavary district underwent extensive trials in the districts. At all the rice research stations, a large number of cultures were in various stages of experimentation.

Among hybrid strains, performances of 10905 and 10783, isolated from a cross between Co 3 and a variety of Burma with thick straw, continued to be promising in low-lying areas subject to short period of submersion. Again, hybrid strains 10998, 11348 and 11340, isolated for their resistance to blast disease (*Piricularia oryzæ*), were found to be free from this disease even when grown in the midst of the badly infested local varieties. At Aduturai, a hybrid strain of Sirumani type for the *kuruvai* season (autumn) was evolved and is awaiting release. Among the economic mutants isolated from X-ray, GEB 24,

a dwarf pure-breeding type, profusely tillering, excels GEB 24 in the yield of straw. However, it easily lodges under highly manured conditions.

As a result of heat-treatment of seed prior to sowing, a progeny of a plant in GEB 24 was found to breed pure for large size of grain. It was identified to be a tetraploid, breeding pure, probably due to the regular formation of diploid gametes during meiosis, though the maximum quadrivalent formation was up to nine. This plant can be economically utilized in inter-specific hybridization with tetraploid wild species of rice. Thirty-six pure-breeding mutations have been isolated for different morphological characters isolated from progenies of X-rayed GEB 24 and Co 4. In addition, 16 lethal mutations mostly chlorophyll deficiencies are carried over in heterozygous condition.

At Coimbatore, though seed graded as heavy yielded better than the light groups, there was no difference in yield between the heavy groups and the ungraded seed of commerce. In a spacing experiment, it was noticed that yields as high as a very closely planted crop in singles could be obtained even in fairly wide spacing, provided the number of seedlings per hole is increased. In the West Coast districts, broadcasting of rice with the first heavy summer showers is definitely more profitable than transplanting after the break of the south-west monsoon. Broadcasting later yields a still poorer crop. In a manurial experiment at Coimbatore, application of superphosphate at planting time with a basal dressing of green-manure, continued to record a significantly higher yield compared to the same applied some time after planting, while at Maruteru superphosphate has no effect on the rice crop irrespective of the time of application. At Pattambi, though groundnut cake to supply 30 lb. nitrogen recorded the highest yield, the application at 5,000 lb. of green-leaf per acre by itself or in combination with sulphate of ammonia was economical. It is recorded that the application of manures, particularly organic manures, contributed to an increase in the thickness of the aleurone layer of the rice grain.

Improved strains evolved at Sabour, BIHAR not only yield 20 to 30 per cent higher than the standard varieties, but also possess non-lodging habit with a greater adaptability to varying conditions of soil and climate of the province. It was found that none of the leguminous catch crops tried (gram, peas and *khesari, Lathyrus sativa*) have any deleterious effect on the growth of the subsequent paddy crop. Under Gaya conditions, application of equal doses of both nitrogen (N) and phosphorous (P) in combination, at 60 lb. each per acre, resulted in a net profit of Rs. 35 to 40, while green manuring with *dhaincha* (*Sesbania aculeata*) gave a net profit of Rs. 15 to 20. Investigations on inducing variation in blooming time during the day, altering the flowering time during the period of growth and the possibility of growing rice in saline areas were in progress.

Rice improvement work in the UNITED PROVINCES is carried out at the two main stations, Nagina and Gorakhpur. At Nagina, the collection of varieties was studied with a view to isolating types suitable to the different parts of the province. Preliminary trials of new selections have shown the probability of the spread of N 22, N 27, N 32, Ch 10, A 64 and T 136 in the unirrigated areas where short-duration varieties are now grown. In the canal-irrigated area, H 108 and T 29 should prove useful, while for the pig-infested sub-montane areas, T 43 has been marked out. Progenies from crosses T 1 and T 12 and some of the early exotic varieties contain some useful materials

for selecting types suitable for the different tracts of the province. Among the F 9 generation of Sathi crosses, three hybrids gave better yields than the Sathi parent under transplanted conditions, while under broadcast conditions, none proved better than the parent.

Among agronomic experiments, the highest yields were recorded with the application of sulphate of ammonia, castor-cake and powdered calcium cyanamide. Green-manuring with *sanai* of different ages again showed the superiority of nine and seven weeks to five weeks growth. Molasses at 100 and 200 md. per acre gave good response and there was no difference in applying it a month or two before planting.

At Raipur in the CENTRAL PROVINCES, three high-yielding hybrid strains, Budhiobako × Parewa 1, 9, and Bhondu × Parewa Nos. 22 and 116 were isolated for areas where the menace from voluntary growth of wild rice in the cultivated crop is a definite handicap. The chief advantage of these hybrid strains is that, as they are pigmented types, the wild paddy plants can be easily spotted and rogued out in the vegetative growth period of the crop. Yield trials with 550 varieties carried out during the past five years at Raipur, Waraseoni and Jubbulpore have proved the superiority of 17 selections. They are being multiplied for distribution. A number of hybrid progenies were under study to investigate the inheritance of aroma, habit, size of grain and endosperm characters. Observations on the percentage of natural cross-pollination in rice showed that under Raipur conditions it varied from 4 per cent within two feet, to 0·2 per cent at a distance of 40 ft. These percentages were found to double themselves in the southern direction. In sandy soils, the application of 10 lb. of nitrogen as sulphate of ammonia and 10 lb. of phosphoric acid as superphosphate was found to be most economical.

Of the three research stations in ASSAM, Karimganj, Titabar and Habiganj engaged in the improvement of rice, Habiganj alone is partly financed by the Imperial Council of Agricultural Research. At Karimganj, 993 types were under study, and 63 types were under yield trials. A *sali* hybrid (S C 412-56) maintained its merit for the second year. Two new types, A C 536-143, a hybrid in *aus* and M 175-1 in Murali, have been recommended for distribution to cultivators. Agronomic experiments on age of seedlings, number of seedlings and time of planting were in progress. Quicker and better germination was obtained by soaking the seed paddy for twelve hours than for longer periods.

At Titabar, 215 types of *aus* and 694 *sali* were under observation. Yield trials were conducted with twelve in the former and 61 in the latter group of varieties. One promising hybrid (S C 308-374) was recommended for trial in the cultivators' lands. A manurial experiment in *aus*, with four treatments, viz. 0-100-200-300 md. of cowdung per acre was conducted in 1936-37. The plots were left unmanured to assess the residual effect of the original application. The result of the second year confirmed that of the first, showing that the application of 300 md. per acre alone had a significant residual effect.

Research on *aman* (deep-water) paddies and *boro* (spring rice) was concentrated at Habiganj. Three high-yielding strains, Habj Nos. 1, 2, 3 in *aman* and Habj 1, 2, 3 in *boro* were released for distribution. Experiments on varietal response to submergence and effect of age on submergence were continued. The height and vigour of plants during the pre-flood period are not always correlated with flood-resistance. It has been observed that deep-water

paddies remain in a state of unstable equilibrium during floods. Rice plants, while growing in deep-water conditions, remain at heights of 20-30 inches above water-level. When there is an abrupt rise of water, this equilibrium is upset and plants try to restore it by further growth. Thus, after each abrupt rise of water, an accelerated rate of growth is recorded. With regard to the ability to withstand submergence for varying periods, the age of the plants after planting counts for more than the varieties in the *aman* group. Two-weeks-old plants suffer most and can hardly stand submersion even for four days. With the increase in the age to four to eight weeks, the plants stand a comparatively longer period of submersion. Plants of six to eight weeks stand submersion up to twelve days. The following important findings were the outcome of cultural experiments conducted in *boro* for some years in Habiganj:

(i) the yield of *boro* is directly proportional to the amount of rainfall in February and March,

(ii) the later the planting, the poorer the yield,

(iii) seedlings of shorter age are preferred during early planting and older seedlings for late planting,

(iv) single seedlings planted close give higher yields in years of inadequate rainfall.

Improvement work in ORISSA is carried out at the main station at Cuttack and at two other sub-stations at Berhampur (Ganjam) and Jeypore. The selection of flood and salt-resistant varieties is being done under natural conditions in the Kujang area, while the work on summer paddies and fine quality *aman* paddies is carried out at Puri and Sambalpur respectively. A fine, medium-duration selection named Utkal sona 812 was released for distribution. Salt resistant variety No. 100 was found to yield well in highly saline areas. With a view to evolving a variety which will be resistant to both salinity and floods alike, efforts are being made to cross *Oryza coarectata* (Nali), growing wild in estuaries, with the salt-resistant type 100. In the Berhampur area, Bam, 1, 3, 5 and 9 recorded an increase of 13, 50, 34 and 39 per cent over the respective locals. Experiments to evolve a drought-resistant type for the Ganjam area and on pre-treatment of seed before sowing to induce flood and salt resistance are in progress. It is interesting to note that smoking of newly harvested seeds successively for two or three days for a couple of hours each day induces them to germinate freely. Incidentally, it was also noted that even paddy grains of recently harvested winter varieties germinate after the husk is carefully removed in a wooden *chakki*.

Research work on the improvement of the rice crop in BOMBAY is carried on at Karjat for Kolaba and Thana districts, at Mugad for the southern Maratha country and at Kumpta and Ratnagiri for the rice crop of the Konkan. A number of strains isolated in these rice stations are being tried in the districts.

In MYSORE hybrid strains × 18 and × 194 were released during the year for cultivation. Results of the manurial experiments at Nagenahally, Irwin Canal and Mattur Farms confirmed the need for green manure as a basal dressing even when cattle manure or compost is applied.

In HYDERABAD the varieties grown were broadly classified into four groups with reference to their duration. Himayatsagar No. 263 is getting to be popular in new villages. Nine promising strains underwent trials in all the district farms before being released for distribution.

In TRAVANCORE the selection made by the Economic Botanist at Nagercoil continued to be popular and 12,479 lb. of seed were distributed. The results of manurial experiment of various varieties of green leaves obtained from jungle growth, *avarai* (*Cassia auriculata*) followed by *konna* (*Cassia florida*) have been consistent, yielding higher than other leaves.

2. Wheat

The total area under wheat was 35,291,000 acres in 1938-39 as against 35,640,000 acres in 1937-38. The estimated production of wheat in India decreased from 10·8 million tons in 1937-38 to 9·9 million tons in the year under report. There was a considerable fall in the overseas demand for Indian wheat as shown by the decline from 460,000 tons valued at Rs. 4,62 lakhs in 1937-38 to 279,000 tons valued at Rs. 2,48 lakhs in 1938-39. In spite of the re-introduction of the protective duty on imports of wheat into India from December 1938, the total imports of wheat during the year were reported to be 159,000 tons as against 22,000 tons in the preceding year.

Breeding

SIMLA. At the Wheat Breeding Station, work on the breeding of rust-resistant wheats is being continued by the Imperial Economic Botanist with the cooperation of Rai Bahadur Dr K. C. Mehta. The nine rust crosses selected previously for intensive study regarding rust resistance were in the F_4 generation this year. Out of a total of 2,640 plants tested, 1,702 proved to be resistant. Plants were selected for F_5 on the basis of rust resistance and other desirable characters. The F_1 populations of seven crosses were tested for reaction to a mixture of all the Indian physiologic races of Black Rust. Susceptibility proved completely dominant in all the crosses and this is in agreement with last year's observation. The cross involving rye as one of the parents proved completely sterile.

Altogether 76 varieties of hill wheats and a large number of foreign and Indian wheats were studied with the object of discovering strains suitable for breeding purposes. None of the hill wheats was found to be suitable for breeding. Some of the wheats from Kenya have shown a promising degree of resistance to black rust. These tests will be repeated to confirm this finding. A study of the correlation between rust resistance and certain anatomical and morphological characters in 16 varieties of varying degrees of resistance has just been commenced.

DELHI. Experiments were conducted at the Imperial Agricultural Research Institute by the Botanical and Mycological Sections to test the reaction of a large number of wheat varieties to loose smut and flag smut. Attempts are being made by careful selection from inbred lines to eliminate the defect of grain-shedding in the otherwise valuable wheats Pusa 114 and Pusa 120. Nine varieties of Pusa wheats were grown absolutely without irrigation, with a view to test the drought resistance of Pusa wheats. The study of the large collection of Indian and foreign wheats was continued. Material of wheats from Afghanistan received from the German Expedition to that country was also under study to discover forms suitable for breeding purposes.

PUSA. From the F_4 generation of wheat crosses, a number of fully bearded and early maturing hybrids showing resistance to rusts under field conditions have been selected.

BOMBAY. Promising selections from various crosses were studied and the best strains selected for further test. In connection with the trials for resistance to black rust, the F_2 of the cross Vernal×Khapli was continued. Khapli 76 was also crossed with Pusa 4 and other varieties.

PUNJAB. While Lyallpur continues to be the chief centre of botanical research on wheat in the Punjab, the two wheat breeding substations at Rawalpindi and Gurgaon have begun to do much useful work. The cross C 409 is considered to be a more profitable wheat for general cultivation, under Rawalpindi conditions, than any other wheat evolved hitherto. C 230, a new cross tried under field conditions for the first time, has surpassed C 591 in yield, though not in quality. It, however, suffers from the disadvantage of being beardless. Two crosses, C 215 and C 217, have outyielded the best wheats at Rawalpindi and they have also given promising results under *barani* or moisture shortage conditions at Gurdaspur and Jullundur.

It is expected that the work on milling and baking tests will be in full swing in the coming year.

CENTRAL PROVINCES AND BERAR. The rust-resistant selections Nos. 76 and 267 and the hybrid No. 281 are now in a position to replace the standard rust-resistant variety A 115. Other fixed hybrids Nos. 311 and 312 bred from rust resistant parents gave encouragiug results on the Government farms. A large collection of foreign wheats is now available for combining their rust resistanee with the economic qualities of local varieties.

UNITED PROVINCES. Pure line cultures of the standard wheat varieties were maintained. Plants from irradiated seeds of C 13 were studied and selections were made for further tests. A study of the interaction between irrigation and varieties revealed positive irrigational effects.

BENGAL. Successful cultivation of this crop in the province seems to depend to a large extent on the facilities for irrigation, except in cases where the land has plenty of moisture and the soil able to retain it.

INDORE. Selectious made from the local Ekdania crop have fared better than any of the introduced strains, though under irrigated conditions Punjab C 591 has done well.

HYDERABAD. Selection of plants and intensive study of the characters in a large number of strains was continued.

Varietal trials, seed multiplication and distribution

The cooperative yield trials of the Pusa wheats in the UNITED PROVINCES and the Punjab were continued. The results are being statistically analysed.

At the Imperial Agricultural Research Institute, NEW DELHI, five Pusa wheats gave a yield of over 40 maunds per acre. The quality of the seeds was also excellent as shown by the high bushel weights.

At the Botanical Substation, PUSA, further tests of seven Pusa wheats with Cawnpore 13 and Punjab C 518 in randomized blocks with six replications each, disclosed that Pusa 52 was the best yielder with Pusa 80-5 coming next.

In BOMBAY, the selection, B G J-1, which was tested in replicated yield

trials with 808, 168 and local, stood second to 808. This improved strain is considered to be suitable for parts of Nasik district. The standard strains 808, 168 and 224 were multiplied for maintenance of pure seed. Altogether 1,040 lb. of pure seed were distributed.

In the PUNJAB, C 518 and C 591, having now become established as commercial wheats of the province, are quickly replacing the hitherto popular Punjab 8 A.

Four thousand and three hundred maunds of pure, smut-free seeds of various commercial varieties were supplied to seed farms and grantee estates, as a nucleus for further multiplication and distribution by them.

In the yield trials at Raya (UNITED PROVINCES), the Pusa varieties 4, 111, 125, 165 and Punjab C 518 ranked high. At Cawnpore, Punjab C 518 and Pusa 125 gave the highest yield.

In RAJPUTANA, in JODHPUR, JAIPUR and ALWAR states, where irrigation is available, Punjab 8 A, and C 591 have given good results.

In SIND, some promising strains were compared with the local variety, three of which gave definitely higher yields.

Physiological studies

Vernalization studies with several crops were continued at the Imperial Agricultural Research Institute, NEW DELHI, and good response has been found in wheat and gram.

In the UNITED PROVINCES, vernalized seeds on sowing displayed high mortality.

Introduction of improved varieties of wheat

AJMER-MERWARA. Improved varieties of the following seeds were multiplied at the two farms maintained by the District Board and distributed to cultivators and these replaced largely the poor-yielding varieties formerly grown by them.

Pusa varieties : Pusa 4, 12 and 52.

Punjab varieties : C 518, 591 and 8 A.

BALUCHISTAN. Pusa 114, C 518 and C 591 were introduced.

BOMBAY. Four hundred ninety seven thousand, five hundred and one pounds of improved wheat seed were distributed through the agency of registered seed growers.

UNITED PROVINCES. The distribution of better seeds through seed stores and societies was pushed on by the Cooperative Department. There were 14 central stores as against two of the previous year and the acreage under improved wheat was 92,224 against 53,349 of the previous year.

PUNJAB. It is estimated that 50 per cent of the total area under wheat consists of improved varieties in a high degree of purity, whereas most of the remaining area is also under improved wheats but of lesser purity. During the year under report, 2½ million acres are believed to be overed by C 518 and C 591 alone.

BIHAR. The demand for Pusa 52 is increasing and it is finding favour with growers because of its higher yield, bearded ears and resistance to drought and disease.

Central Provinces and Berar. Considerable progress has been made in this direction.

North-Western Frontier Province. The Agricultural Department has achieved great success in this line. The improved wheats introduced into the province yielded nearly 20 times the seed used by the growers for sowing. Pusa 4, Federation, C 591, 8A and Bena have gained the confidence of agriculturists.

Sind. The Department of Agriculture has organized a scheme for multiplication and distribution of pure seed of improved varieties of different crops including wheat and the areas under such crops are extending rapidly.

Delhi. Seeds of the following improved varieties of wheat have been brought into use on a field-scale in the villages: Punjab 8A, 9D, C 518 and C 591.

3. Cotton

The area under cotton in India decreased to 23,482,000 acres in 1938-39 from 25,746,000 acres in the previous year, the reduction being recorded mainly in the provinces of Madras, Bombay, the Punjab and the Central Provinces and Berar. The ascertained area under improved strains during the year was 5,663,000 acres or 24 per cent of the total, against 5,651,000 acres or 22 per cent of the total in the preceding year. The total out-turn of lint was estimated at 5,076,000 bales of 400 lb. each in 1938-39 against 5,722,000 bales in 1937-38, the average yield per acre being 87 and 90 lb. respectively. Unfavourable weather conditions during the growing period were mainly responsible for the reduced yields obtained in the cotton tracts of Madras, Sind, the Central Provinces and Berar and the United Provinces. The quantity of cotton pressed, including unpressed (loose) cotton consumed in mills in India during the year and the extra-factory consumption of cotton, taken at 450,000 bales, amounted to 6,019,000 bales of 400 lb. each.

The exports of Indian cotton during the season totalled 3,367,000 bales against 2,100,000 bales in 1937-38. The increase was due mainly to a marked recovery in China's demand for Indian cotton and to the larger off-take by Japan than in the previous year. The exports to the United Kingdom amounted to 402,000 bales during the year, against 362,000 bales in the preceding year.

The total consumption of Indian cotton in mills in India during the season under report established a new record, being 3,121,000 bales of 400 lb. each against 2,994,000 bales in 1937-38. The increase was largely in the provinces of Madras and the United Provinces and to a less extent in the Central Provinces and Berar, the Punjab and Delhi. It is noteworthy that the consumption in the Madras Province has steadily increased from 1933-34 and the quantity consumed in 1938-39, viz. 471,000 bales—a record for the province—was more than twice the figure of a decade ago.

The Bombay Cotton Forecast Improvement Scheme, sanctioned by the Committee in 1934 for a period of five and a half years, terminated during the year and the final report on it was published for general information. The sources of discrepancies in the three factors—area, anna valuation (or condition factor) and standard yield—involved in the preparation of cotton forecasts

have been discussed in the report and remedial measures suggested for improving the forecast. Some of these measures have been given effect to in the Bombay province, while others are under examination.

Statistics were compiled and published as usual dealing with the consumption of Indian cotton by Indian mills, the extent of accuracy of the all-India cotton forecasts, the distribution of the crop by staple length, and the receipts of cotton at mills, exports by sea and stocks held in India classified by varieties.

Cotton legislation

The application of the Bombay Cotton Control Act to the area south of the Narmada has resulted in the complete eradication of Goghari cotton in that area. There is, however, the potential danger of the spread of another variety inferior to 1027 ALF, viz. selection 1A in parts of the Surat district where Goghari was formerly grown, and if the extension of this cotton is to be controlled, the act would require to be so amended as to empower the provincial Government to prohibit the cultivation and handling of any type or types of cotton in specified areas.

The Bhopal Cotton Control Act, the enactment of which was referred to in the last review, is proposed to be put into operation after two or three years, by which time it is hoped that adequate provision for the supply of pure seed will have been made.

Under the Cotton Transport Act, 1923, the protected areas in the Bombay province remained unchanged except that Olpad and part of Chorasi taluka were isolated from the rest of the protected area lying south of the Narmada. As a result of this, most of the cooperative cotton sale societies in Olpad have already taken up the cultivation of the improved 1027 ALF cotton.

The Gwalior State have issued a notification prohibiting the import of Rajputana cotton into the state and declaring the districts of Shajapur, Ujjain, Mandsaur and Sardarpur to be protected areas under the Cotton Transport Act. The Government of India have also issued parallel notifications under section 4 of the Act.

Section 14 of the Cotton Ginning and Pressing Factories Act and rule 7 of the rules framed thereunder were amended during the year to obviate certain hardships felt by the trade from the strict application of the original provisions. Section 9 of the Act was also amended during the year to provide against loopholes in the provisions relating to structural requirements of factories.

During the year the Cotton Ginning and Pressing Factories (Bombay Amendment) Act, 1936, as amended by the Bombay Amendment Act, 1938, was put into operation. The Baroda Darbar have also amended the Baroda Cotton Ginning and Pressing Factories Act, 1925, on the lines of the Bombay Amendment Act, 1936, but the rules have not yet been framed.

In view of complaints regarding the presence of extraneous matter such as pieces of jute and twine in baled Indian cotton, trade bodies and prominent commercial firms have been requested to report such cases with particulars of press marks and running numbers of the bales complained of to enable the matter to be followed up. It has also been suggested that the exporter, the merchant or the spinner concerned should intimate to the factory concerned

that if such malpractices continued their cotton would not be purchased. The provincial Governments have been requested that if, in any particular season, complaints against a particular factory exceed a certain number, say 10, the question of stopping the factory from working for one season should be considered.

Cotton markets

During the year, three new markets were established under the Bombay Cotton Markets Act, viz. at Hubli, Gadag and Nargund, thus bringing the number of such markets to 12. In the Madras province, Nandyal and Adoni municipalities have been notified as markets for cotton under the Madras Commercial Crops Markets Act. In the Punjab, the Punjab Agricultural Produce Markets Act has been passed, providing for the better regulation of the purchase and sale of, and the establishment of markets for, agricultural produce including cotton.

Reference was made in the last review to the inclusion of cotton in the schedule to the Agricultural Produce (Grading and Marking) Act. The rules under the Act in respect of cotton have been finally published.

The Karachi Cotton Association have now adopted the Universal standards of the Committee as the basis for their own standards. The Committee has also recommended to the East India Cotton Association that trading in the Bombay market should be transacted on the basis of the Universal standards of the Committee. As the standards for Berars and Broach of the Liverpool Cotton Association were found to be much inferior to and not at all representative of the actual growths of the cottons, arrangements have been made for the supply to them of copies of sets of standards used by the cotton associations at Bombay and Karachi.

(a) Fundamental research

Fundamental research on cotton genetics, physiology and agronomy was continued at the Institute of Plant Industry, Indore, on the lines of the previous years.

Cotton genetics. A new member of the anthocyanin allelomorphic series has been identified in one of the Madras types, Tellapatty, which has no pigment in the plant body but only a petal spot. This was crossed with three pigmented types and with one having a ghost spot. There was a simple monohybrid segregation in every case, the F_1 being distinguishable, with lighter pigment at the petiole insertion point with the lamina. The independence of the sterility gene in the Million Dollar mutation to the anthocyanin and petal colour genes has been confirmed. It would appear that it is independent of the leaf shape gene also. Preliminary cytological observations on the mutant would appear to show that sterility is due to partial asynapsis. While further studies regarding the interrelationship and linkage values of the several lintless genes in Asiatic cottons are in progress, they have brought out the rather complicated nature of the genetics of 1027 lintless gene.

Genetic variability. Only one year's results have so far been published on the genetic variability in intra-species crosses, with regard to agricultural

characters, such as germination, node number, yield, staple length and ginning percentage. The data collected during the last two seasons are being analysed by the Institute's Statistician under the guidance of Prof. R. A. Fisher. The results when published should prove to be of considerable value to plant breeders in the study of quantitative characters.

To test the assumption that the value of an F_2 for selection in plant-breeding work is proportional to its mean and genetic variance, the Bengals hybrids, whose F_1s were compared last year, were experimented with during the year. The characters studied were germination and stand, ginning percentage, lint length and yield. Last year's results had shown the outstanding value of Shan material as a parent, more particularly with regard to improving lint length. The F_2 results have confirmed the above findings and shown that out of the four sets of crosses—Rajputana × Mollisoni, Rajputana × Cwn 520, Shan × Mollisoni, Shan × Cwn 520—selection should be confined to the last two. The experiment with the F_1s repeated during the year was laid down in a wilt-infected field and observations on mortality due to wilt have given additional information in favour of the Shan × Mollisoni and Shan × Cwn 520 crosses for obtaining resistant types.

Physiology. That the quality of fibre and its spinning value is influenced by the type of land on which it is produced has again been confirmed. Two acclimatized Upland (American) types were grown on *adhan* land at Kharua and on *barani* land in Indore. The lint from the former shows an increase in fibre length, a reduction in fibre weight and about 20 per cent improvement in spinning value over the latter. Incidentally, it has been observed that the improvement in the quality of the produce from *adhan* land is associated with a fall in ginning percentage as compared with the produce from the *barani* land. The difference in ginning percentage is evidently brought abont by the greater seed weight of the produce from *adhan* land. This association would appear to apply equally to *desi* cottons also. When a number of Malvi strains are grown for comparison both in Kharua and in Indore, the produce of the former place always shows a higher seed-weight and a lower ginning percentage than the produce from the latter.

The experiments on the competition effects on *desi* and Upland cotton when grown in close association were repeated to include local unselected material in addition to selected types. These have given extremely interesting information. The results previously obtained that the Upland variety suffers less and less from red leaf and leaf roll with increasing association with *desi* were again brought out. There is also evidence that the Upland variety gains in yield at the expense of *desi*, due to competition effect, and that this effect is even more pronounced in the unselected local type and in the trial laid out on poor land. The *desi* type has given the highest yield in the pure plot. Since there was a certain amount of wilt incidence in the fields where the experiments were carried out, periodical mortality counts in *desi* were recorded. These records once again showed that the association or close proximity to the Upland gives the *desi* a measure of protection against wilt, the mortality being least in the plot where *desi* and Upland cottons alternated and in the mixture plot.

The experiment to find out a physiological explanation for the differential survival values of the four genotypes comprising the *desi* cotton in Malwa

and Nimar was continued. While the data have not been completely analysed yet, the dry weight figures of the vegetative and fruiting parts very clearly indicate that Malvi is the most efficient type for Malwa and Malvi and Roseum the most efficient types for Nimar, which confirm the results of census studies. The preponderance of the Roseum type in Nimar is undoubtedly the result of human efforts to introduce this cotton in the tract and is not due to its inherent greater adaptability to the conditions than Malvi.

Cotton agronomy. From the series of field trials which have been carried out since 1934, some useful results of practical importance on the manuring of cotton have now emerged. On the black cotton soil of Malwa the response to manure has been found greatest on well-drained land of high or medium fertility. Any permanent rise of sub-soil water into the zone of the feeding roots during the rains inhibits the manurial effect. The most profitable manure appears to be Nicifos 22/18. Over a range of trials, with applications varying from 40 to 140 lb. per acre, yields of *kapas* increased by 30 per cent to 85 per cent. The value of the increased yield over the unmanured control plots, allowing for the cost of the manure given, ranged from Rs. 5-15 to Rs. 16-8 per acre.

Breeding and selection. Two selected strains of pure *desi* cotton, Malvi 1 and Malvi 9, have been evolved for growing under *barani* conditions; both of these are superior to the mixture commonly grown. In addition, a strain of Cambodia cotton, known as Indore 1, has been developed for growing on the *adhan* lands. This strain has given good results under irrigation in parts of Jodhpur and Ajmer. In Rajputana, extensive trials carried out on the Bikaner Gang Canal have shown that both C 520, a *desi* cotton from the United Provinces, and Punjab-American 289 F and 43 F are promising. In both Indore and Dhar states a cotton-seed distribution scheme is now being worked and is making good progress.

Cotton survey. During the year, at the instance of the Indian Central Cotton Committee, a survey of cotton in Baluchistan was undertaken. The import of cotton into the Kathiawar ports from the Makran coast is already prohibited to prevent the introduction of any new pests or diseases into India, but since part of Makran lies in Baluchistan, it was considered desirable to collect information regarding the nature and extent of cotton cultivation in that area. The assistant who carried out the survey of Iran cotton was detailed for this work. In addition to surveying the Makran coast, he also visited the cotton areas in North Baluchistan. While in Makran the cotton grown is still *herbaceum*, in N. Baluchistan, the indigenous *herbaceum* has been completely replaced by Sind and Punjab-Americans. A fair number of representative samples, both single plants and bulks, have been brought from Makran and examined at the Institute, but they do not appear to compare favourably as breeding material with similar material brought from Iran two years ago. The *herbaceum* grown in Baluchistan is neither earlier than nor superior to the Indian *herbaceums*. In so far as the incidence of pests and diseases is concerned, the material brought was examined by the Imperial Mycologist and the Entomologist; stenosis was the only disease present to any extent and, among the insect pests, the chief were the two bollworms, white fly and plant lice. It would thus appear that there are no pests or diseases present in Makran which are not already met with in India.

(b) Cotton research in provinces and states

The work of cotton improvement in India continued to be largely financed by the Indian Central Cotton Committee. A brief review of the work done on the schemes financed by the Committee in the various cotton-growing provinces and Indian states is given below.

MADRAS. *Pempheres and physiological scheme.* As it was felt that the possibilities of biological control were doubtful and that bio-chemical research was also not a hopeful line of attack, the Committee decided that these two sections should be closed down on the 31 October 1938 and the 31 August 1939, respectively. The botanical research was, however, extended up to October 1941. The physiological investigation was also terminated on the 31 October 1938, as it was felt that the experimental work had been brought to a stage when further investigations could be continued by the Agricultural Department itself.

During the year, the three Brazilian types, viz. Quebradinho, Verdao and Moco, which were found resistant to the attack of the stem weevil but seemed to suffer from certain handicaps from the economic point of view, were crossed and backcrossed with Co 2 and their progenies studied both at Coimbatore and Srivilliputhur. The results of testing 340 cultures at the latter centre showed that only one culture of Moco was completely immune to adult emergence or mortality, whilst another showed 5 per cent adult emergence with no mortality. Similarly, 833 cultures tested at Coimbatore showed that 14 cultures were equal to or better than Co 2 in respect of yield with 5 per cent adult emergence and mortality. One culture, viz. 7178, however, has consistently shown high resistance during the last four years.

From the bio-chemical standpoint, it has been established that gum formation occurs earlier and quicker in the Brazilian varieties than in Cambodia on account of changes in the water-soluble polysaccharides of the plant.

The chief internal parasites of Pempheres were found to be Chalcidoids, spotted Spathius and Dinarmus. Other host plants, besides cotton, on which the pest was met with, were *Malvestrum*, *Hibiscus vitifolium*, *Hibiscus ficulneus*, *Sida actua*, *Sida glutinosa* and *Urena*.

The physiological investigations have shown the new strain K 1 to be best suited to withstand untimely rains. Strains 3999, 72 and 110 are also stated to have given good results. Thick sowing of cotton has been found to improve the yield and to be beneficial under conditions of untimely rainfall.

Scheme for improvement of Mungari cotton. During the year, the season was abnormal, higher rainfall during the period of growth prolonging the pickings. The eight strains which were found to be equal to the local mixture last year were again tested in randomized blocks, replicated six times. Of these, five strains, viz. V 434, 6042, X 4383 (Cambodia × U 4), M 274 and P 26H again equalled the local mixture in yield. Late Verum, V 434, P 26H, M 274 and X 4383 were tested at five places in the Bellary, Anantpur and Kurnool districts; in one place, the American strain, X 4383, proved distinctly better than the local Mungari, while in the remaining four places its yield was equal to that of the local. In view of the very satisfactory performance of this strain in respect of both yield and spinning value (42's against 10's of Mungari), arrangements were made for the multiplication of its seed and tor observing

its behaviour on a field scale. The reports received so far are stated to be encouraging and if these are confirmed in subsequent trials, it may be necessary to review the breeding work of the scheme so as to make suitable alterations in the future programme.

Nadam cotton breeding scheme. Although the total rainfall during the year exceeded the average, the distribution was unfavourable and this acted adversely on the annual varieties of cotton ; the perennial Nadam type, however, benefited by the heavy summer rains and yielded well. One hundred and eighty three cultures were compared in replicated progeny rows. Of these, 148 were from the American varieties, made up of 46 cultures of the previous season and 102 selections from single plants in F_2 and F_3 generation of Co 2 × Russian hirsutums. Ten strains amongst these yielded more than 300 lb. per acre but only three were found to be statistically superior to the standard. Out of the 35 Asiatic cultures tested, five yielded more than 300 lb. per acre ; four of these were derivatives from Nadam-Karunganni crosses. Nadam yielded only 80 lb. per acre.

Two sets of Asiatic and American strains, each consisting of five strains, besides Co 2, were tested for yield in replicated randomized blocks. The Asiatic strains, in general, fared better than the American ; the K 1 strain from the former group giving a yield of 300 lb. per acre and spinning up to 32s highest standard warp counts. It may be mentioned that the Department of Agriculture has been distributing the seed of this strain in the Coimbatore district and if the present standard of yield is maintained during the next two years, the object aimed at by the scheme will have been achieved.

Madras Co 2 seed distribution scheme. During the period, there were 3,200 acres under seed farms and the production of seed amounted to 10,758 mds. as against 5,350 acres and 52,584 mds. of seed during the previous year, the fall in acreage and production being due to the failure of seasonal rains and consequent damage to the crop. Aided by natural spread, the entire Cambodia tract in the Coimbatore district is now reported to have been covered by Co 2 strain. The premium obtained per 784 lb. of Co 2 cotton over local Cambodia ranged from Rs. 5 to Rs. 12-8 in 1938 against Rs. 10 in 1939. The gain to cultivators is calculated to be not less than Rs. 15 per acre over the local variety.

BOMBAY. *Broach cotton breeding scheme.* Strain BD 8, which is highly resistant to wilt, was crossed with several high ginning types and 14 successful crosses have been obtained. During the year, nine of these were tested in replicated trials for wilt resistance, ginning out-turn, fibre length, spinning capacity and yield. The seed of the best plant from each of the nine segregates was sown in nine randomized replications, both in wilt-infected and wilt-free soil.

Some promising selections were obtained from crosses of BD 8 with 57-1 and NS 12 and the segregates (BD 8×S7-1)-F6-10-15-3-2 [BD 8×(BD8× S12-1-F1)] F4-3-1-3 and five plants from cross (BD 8×NS 12) F4 with ginning percentage of 37·6 to 39·8 and staple length of 21·0 to 21·7 mm. have been selected for further trials.

Jalgaon cotton breeding scheme. As a result of the work extending over five years, a variety known as Jarila (NV 56-3) has been evolved and, during the past three years, this has been undergoing trials and has been reported upon favourably.

Twenty-seven plant selections of last year, isolated from the material obtained from the Amraoti district, along with 11 newer selections, were tested in progeny rows. Of the 120 plants selected from these, 41 were found to be superior to the average Jarila plant, in respect of staple length, ginning percentage and yield; these will be grown in replicated progeny rows for testing their ability to resist wilt.

To introduce the character of immunity to wilt and high ginning percentage in Jarila, the F_1 of the cross (Jarila × NR 5) was crossed with New Million Dollar—a wilt immune strain and 51 successful crossed bolls were obtained, seed of which will be tested next year.

In the extensive village trials conducted in 44 centres in Khandesh and part of Nasik district, the results in six places were vitiated due to natural or other causes. In the remaining 38 trials, Jarila yielded more than the local in 16, gave nearly equal results in 10 and yielded less than the local in 12. Taken collectively, there was no significant difference between Jarila and the local, though last year the difference was significant. The ginning percentage of Jarila this year ranged from 33 to 38.

Both farm and commercial samples tested at the Committee's Technological Laboratory were adjudged suitable for 27 to 30 highest standard warp counts. Tests on five bales carried out at the Tata and Sassoon Mills, Bombay, however, gave 21 to 22 counts (average), with strengths varying from 50 to 70 lb. The lint was valued at Rs. 16 to Rs. 45 over Broach by the Millowners' Associations of Bombay and Ahmedabad. The prices realized at the auction sales at Jalgaon in January and March 1939 ranged from Rs. 23 to Rs. 48 on Broach, for the farm and registered seed growers' produce.

Scheme for improvement of Wagad cottons at Viramgam and Jagudan. During the year, 104 selected plants from Wagad (representing 36 families) and 46 additional ones were grown in progeny row cultures. Of these, 17, which appeared equal to or higher than the local Wagad in ginning percentage (though lower than Wagad 8), were retained for further trial. Most of these are superior to both in fibre length and some promise to be better yielders than Wagad 8. From the remaining cultures, 31 individual plants with a ginning percentage ranging from 35 to 46 and fibre length from 20 to 24 mm. were selected for next year's progeny-row test.

With a view to replacing the inferior Mathio cotton of Kathiawar with early *herbaceums*, crosses were made between (1) Wagad 8 and Russian *herbaceums*, (2) Wagad 8 and Persian *herbaceums* and (3) Wagad 8 and East Iran and early *herbaceums* from Trinidad. The F_1 generation of the above three was back-crossed with Wagad types 99, 101 and Seg 4-1 and the backcross population will be studied next year.

In a variety trial experiment with five varieties, viz. Kanmi-local, Chokadia, Broach 9, Seg 7-1 and Wagad 8, Seg 7-1 proved to be the best in point of yield, ginning percentage and fibre length. The suitablity of this strain for the Lalio tract, which represents about 25 per cent of the area under cotton in the Mehsana district, will be tested in the ensuing year.

Scheme for breeding wilt-resistant cottons in Surat area. The testing work during the year was done in the specially wilt-infected plot at Shera. Out of the 950 plants of the composite cross (BD 8 × 1A LB) × 1027 A.L.F. F5 tested, 15 plants with a ginning percentage of 35 to 40·1 and a staple length of 24 to

25·2 mm. were selected for further study. Out of the 203 plants studied in a non-infected field at Surat, 17 plants with a ginning percentage of 33·4 to 38·7 and staple length from 23·8 to 25·2 mm. were retained for testing their wilt-resistance.

From the 38 plants of the composite cross $[\{\{(BD\ 8 \times NS\ 12) \times 1027\} \times 1027\} \times BD\ 8\text{-}B3]$ F1 grown at Shera, 11 plants with ginning percentage ranging from 29·7 to 37·5 and staple length varying from 22 to 25 mm. were selected for further study.

The progeny of 66 plants of 1027 ALF selected for wilt-resistance at Surat were tested at Shera. Fifty-seven selections proved completely susceptible and from the progeny of the remaining nine, comprising 432 plants, 12 plants were retained for further work as these did not show either root discoloration or any other symptom of wilt.

Scheme for survey of Goghari cotton in Gujarat. During the year, it was reported that, as a result of the passing of the Cotton Control Act of 1935, Goghari had been completely eliminated ; the scheme was therefore closed down in March 1939.

Plant-puller propaganda scheme in Surat, Broach and Panch Mahals districts. This scheme has for its object the eradication of the spotted bollworm by the uprooting of cotton stalks by means of plant-pullers.

The year under review is the fifth year in which propaganda was carried out in the districts of Surat and part of Broach where a thorough clean-up campaign was not previously carried out. Intensive propaganda was conducted in Jambusar taluka of the Broach district where the campaign had not made good progress. Due to continuous and heavy rains during the year, the growth of the cotton crop was not vigorous, the stalks remaining thin and stunted and thus affording easy and convenient removal by *kudalis* instead of by plant-pullers. This, it is reported, accounted for the lower percentage of the area uprooted by plant-pullers compared with that of the last year.

Scheme for inclusion of Northerns and Westerns cottons in the programme of work of dry farming scheme at Bijapur. The season during the year was excellent throughout the Bijapur district, the rainfall being nearly 25 per cent above normal and its distribution favourable. The results of the experiments could not therefore be taken as conclusive. The work under the scheme was divided into two parts. In the first part, six replicated and randomized experiments were laid out to test the comparative performance of the four strains, viz. N-14, H-1, Jayawant and the local-Kumpta and the effect on them of farmyard manure and castor-cake. The other five experiments were laid down to assess the value of different operations and treatments included in the Bombay dry farming method, viz. tillage, bunding, inter-culture, spacing, rotation, fallowing and green manuring.

In the second part, Northerns and Westerns cottons were tried on a field-scale under the Bombay dry farming method for comparison with the local cultivators' method.

In the large-scale field trials of Northerns and Westerns under the Bombay dry farming method, the highest yield was obtained when all the six treatments enumerated above were combined. Addition of farmyard manure

resulted in increasing the yield of two cottons by more than 75 per cent or more than 230 lb. per acre as compared to that of the local cultivators' method. The improved treatment without manuring or ploughing showed no difference over the local method.

Scheme for interspecific hybridization in cottons at Surat. During the year, all original 23 hybrids obtained by crossing Asiatic and American cottons were maintained as ratoons and propagated vegetatively by cuttings and graftings. The hybrids, though vigorous and flowering profusely, were sterile and to bring about fertility in them, three methods were tried, viz. (1) back-crossing, (2) physical treatment and (3) chemical treatment. Nearly 1,53,000 flowers of the hybrid plants were back-crossed and gave 43 bolls with 55 seeds. The second method failed to give the desired results. The chemical treatment, known as the 'Drop and Immersion' method of applying colchicine to growing buds and tips of shoots, had only a temporary effect, though retardation of growth and marked thickening of leaves of the affected parts of the plant were perceptible in the initial stages. This chemical, however, when tried on germinated seeds of 1027 ALF and 1A Long Boll, for inducing doubling of chromosomes to facilitate easy cross fertilization, gave promising results. The treated plants have formed a few bolls and the seeds, if obtained, will be tried next season. The progress of this experiment is being watched with great interest. Another chemical known as acenapthene, which is considered as potent as colchicine in inducing doubling of chromosomes, and subsequent fertility in interspecific hybrids, is also being tested.

A number of crosses were made within species and between different wild and cultivated species to produce artificial amphidiploids, for use in crossing and to test the supposed theory of amphidiploidal origin of the New World cultivated cottons.

Surat seed distribution scheme. During the year the Department of Agriculture controlled a seed multiplication area of 11,756 acres (including 864 acres grown with farm pedigree seed) against 26,618 acres (including 1,160 acres with farm pedigree seed) in the previous year and distributed 19,63,486 lb. of seed (including 9,42,862 lb. supplied to Indian states) against 29,36,110 lb. (including 16,60,449 lb. supplied to Indian states) in the previous year. As a result of the amendment of the Bombay Rules under the Cotton Transport Act, 1923, restricting the importation of inferior types of cotton into the Surat tract, there was a good demand for 1027 ALF seed which was further enhanced owing to the increase in the import duty on foreign cottons, with the result that fairly reasonable prices for this cotton were obtained and stocks easily disposed of.

Khandesh (Jarila) seed distribution scheme. During the year, 97,990 lb. of Jarila seed were sown over an area of 4,836 acres, against 6,868 lb. over 390 acres last year. The natural spread of this variety is estimated at 5,000 acres. 5,19,257 lb. of pure seed were purchased and stocked fc distribution during the next season. Jarila is reported to have given an average yield of 269½ lb. per acre against 229 lb. of the local variety. 2,311 *docras* (about 1,100 bales) of cotton were ginned under departmental supervision and sold by auction at a premium of Rs. 38 to 48 on Broach against Rs. 26 to Rs. 46 on Broach, obtained in the previous year.

Deccan canals (Banilla) seed distribution scheme. During the year, 51 acres and 20 *gunthas* were under cotton and 24 acres under groundnut at the Kopergaon Government Farm. A yield of 534 lb. of *kapas* per acre was obtained against 368 lb. per acre in the previous year and 678 lb. per acre in the year before. The cotton crop was affected by uneven rainfall distribution, attack of green caterpillars, red cotton bugs, pink bollworm and growth of weeds. Comparative trials of Banilla and Jarila gave yields of 760 lb. and 774 lb. per acre, respectively.

BD 8 seed distribution scheme. During the year 14,294 acres were under BD 8 as against 6,268 acres in 1937-38 and 20,012 acres in 1936-37. The total area under cotton in the Broach district (excluding Ankleshwar taluka) is 250,000 acres. 10,208 bales of pure BD 8 were produced and sold through sale societies and gin-owners at premiums ranging from Rs. 30 to Rs. 54 on Broach. Last year 2,035 bales were produced, of which 1,770 bales were sold through sale societies and gin-owners.

Revised Jayawant and Gadag No. 1 seed distribution scheme. During the year, 30,99,320 lb. of pure Jayawant seed were sown over an area of 3,24,197 acres, against 27,55,200 lb. of seed sown over an area of 2,45,318 acres last year. The natural spread of Jayawant is estimated at 1,75,000 acres, bringing the total area under this variety to about 5,00,000 acres. 11,29,600 lb. of pure Gadag No. 1 seed were sown over an area of 1,12,944 acres, against 12,95,700 lb. of seed sown over an area of 92,539 acres last year. The natural spread of this variety is estimated at 35,000 acres making a total of 1,48,000 acres. 45,91,860 lb. of Jayawant seed and 13,46,400 lb. of Gadag No. 1 seed have been purchased so far for distribution in the 1939-40 season.

The cultivators' produce was pooled and sold by auction at different centres and sub-centres. In all 29,108 *docras* of Jayawant and 31,895 *docras* of Gadag No. 1 were sold during the year, against 16,468 *docras* of Jayawant and 26,975 *docras* of Gadag No. 1, last year. The extra profit realized by cultivators from auction sales is estimated at Rs. 84,000 for Jayawant and Rs. 80,000 for Gadag No. 1.

SIND. *Scheme for cotton jassid investigation.* During the year, the biology of the pest and its comparative infestation on different cottons were studied. Two species of the pest were found to attack cotton and other crops. The first ***Empoasca devastans*** Dist., which is readily recognized by the presence of two small black spots, one on each side of the apical end of the tegmen, is found largely on cotton, *bhindi* (*H. esculentus*), brinjal (*Solanum melongena*) and potato (*Solanum tuberosum*). The other species may be ***Empoasca formosana* Paoli**, in which the black spots are absent. It mainly occurs on *guwar* (*Cyamopsis psoraloides*), *wal* (*Dolichos Lablab*), cowpea (*Vigna catjang*) and berseem (*Trifolium alexandrinum*). The female of ***Empoasca devastans*** Dist. lays her eggs in the veins of cotton leaves. The egg is oval in shape and dull white in colour. The period of egg-laying varies between four to six days in hot weather and extends up to 15 days in cold weather. The maximum capacity of egg-laying may be near about 26. The nymphal life is found to vary from seven to eight days from August till the end of October. Nymphs of all instars pass their life on the under surface of the leaves and moult five times prior to reaching the adult stage. The maximum life of adults is 27 days during summer and 50 days during winter.

A study of the relative abundance of the pest on the important cultivated varieties of cotton in Sind, viz. Sind Sudhar, 4F 98, Sea Island, Boss III-16 and Sind NR, was undertaken and it was found that all the varieties were susceptible, the intensity of attack varying in different varieties. Among *desi* cottons, Sind NR was found to be less susceptible. Parbhani-American and Buri AK Special were found to be less attacked, like Cambodia. There seems a possibility of utilizing these three varieties for crossing with Sind Sudhar and 4F 98. Observations made on the comparative infestation of Sind Sudhar and 4F 98, when sown on different dates, showed that the attack was least in the early-sown than in the late-sown crop.

Scheme for investigation into black-headed cricket in Sind. This scheme aims at establishing the identity of the pest, and studying its life-history, seasonal behaviour and the extent of damage caused by it. Before the opening of the Lloyd Barrage, the black-headed cricket had been known as an occasional pest of *sorghum* and cotton in Upper Sind and some parts of the Punjab. With the introduction of cotton cultivation on the right bank of the Indus, however, this insect has become a serious pest of cotton in the seedling stage in Khirtar and Johi tracts in Sind and in some parts of Baluchistan. The pest appears in the cotton fields towards the end of April and disappears in June. The period of its activity synchronizes with the sowing time of cotton and causes almost wholesale destruction of the crop. The pest appears to belong to the same species as met with in Baluchistan, viz. *Gryllulus domesticus*.

The scheme started late in the season, at a time when the pest is not found to be active in the fields. A thorough survey of the affected tracts has, however, been made and the various types of crickets found, collected.

Sind seed distribution and extension scheme. On the left bank, during the year under report, 5,48,500 acres were under improved varieties, representing 59·4 per cent of the area under cotton in Sind, against 5,05,000 acres representing 52·3 per cent of the area in the previous year. 15,052 mds. of Sind NR, 31,524 mds. of Sind Sudhar and 8,562 mds. of 4F 98 were distributed during the year, against 2,908 mds. of Sind NR, 11,569 mds. of Sind Sudhar and 13,980 mds. of 4F 98 distributed in the past year. 29,274 mds. of Sind Sudhar sufficient for 64,500 acres and about 3,751 mds. of Sind NR sufficient for 10,000 acres were distributed to registered growers for sowing in the 1939-40 season. In order to obtain a supply of pure seed, the Sind Government have established a ginning factory at Mirpurkhas where the produce of Government farms and a few selected growers is ginned. During the year, 10,200 mds. of *kapas* were ginned and sold under the supervision of the Agricultural Department. The cultivators realized 4 to 8 as. more per md. of *kapas* than the local rate by getting their produce ginned at the Government ginning factory and selling the lint and seed separately.

On the right bank the quantity of improved seed distributed in 1938-39 was about 10,000 mds. of 4F 98.

PUNJAB. *The Punjab botanical scheme.* The principal feature of the year was the spread of the improved *desi* and American cottons over large areas. Among *desi* cottons, strain 39 Mollisoni covered an estimated area of about 300,000 acres and is now regarded as the premier *desi* cotton of the province; so far there is no other *desi* cotton which can compete with it either in yield or ginning out-turn. Next in order comes 119 Sanguineum, which is eminently

suited to the south-western portion of the province, viz. the districts of Multan, Muzaffargarh and Dera Ghazi Khan. Its chief merits are early maturity, high yield, high ginning percentage (35-36) and drought resistance.

Among American cottons, 289F/43, which has established itself as one of the leading varieties of Punjab-American cottons, occupied an area of 100,000 acres. Its chief merits are early maturity, drought resistance and high yield which is better than that of 4F.

Attempts are being made to improve the staple of *desi* cotton by crossing Punjab Mollisoni with Chinese Million Dollar. With a view to combining the desirable characters of two or more strains into one, hybridization work is in progress. Special mention in this connection may be made of the cross made between 289F/43×CBS for evolving a strain with long lint, high ginning out-turn and naked seed.

Two multiple-factor experiments, one involving varieties, date of sowing and fertilizers, and the other varieties, date of sowing, spacing and nitrogenous manure, were carried out ; the results showed that :

(i) 289F/43 was significantly better than LSS ;
(ii) 1st June was definitely a more suitable time for sowing than 1st May ;
(iii) a combination of nitrogen and potash was definitely better than no manure or complete artificial manure ;
(iv) the interactions between the varieties and the sowing dates, between varieties and manures, and between manures and sowing dates were insignificant ; and
(v) the interaction between varieties, manures and sowing dates was significant.

During the year, 38,500 bales of 289F/43 and 1,13,333 bales of 39 Mollisoni were produced, the profit realized by the cultivators being estimated at Rs. 93,750 and Rs. 7,50,000 respectively.

Physiological scheme. Partial failures of the American cotton crop in the Punjab occurred in the years 1919 to 1921, 1926 to 1928, 1931 and 1932. The external symptoms of the cotton plants during these failures were early reddening and shedding of the leaves, premature opening of the bolls with immature seeds and low quality lint and, in extreme cases, the dwarfing of the plant. To account for these failures, various views were advanced, such as the heat stroke theory (Milne, 1924), attack of White Fly (Roberts, 1929) and unfavourable combination of climatic and biotic factors (Trought, 1931). As, however, these theories could not be supported by sufficient data, it was thought that these failures were due to malnutrition of the plant. A physiological scheme was accordingly started in March 1935 to study the physiology of the cotton plant with a view to determining, if possible, the nature of the nutritional disorder known as *Tirak*, the causes underlying it and finding out measures to remedy it.

The work of the last four years has indicated that two sets of soil conditions are associated with the development of *Tirak*, (1) soils which contain alkali salts in the sub-soil from the second or third foot downwards and (2) soils with extreme nitrogen deficiency. These conditions may exist either separately in separate fields or together, the intensity varying from field to field. *Tirak* on the first type of soil with the alkali salts cannot be ameliorated by the application of manures, which only results in vigorous growth. It can,

however, be successfully ameliorated by sowing the crop about the third week of June. The yield is also considerably higher than that of the May-sown plants which get 'diseased' on such soils. Closer spacing of plants than the normal practice of 3-ft. distance between the rows is essential in the case of the late-sown crop.

Tirak on sandy soils deficient in nitrogen can be remedied by the application of nitrogen in the form of sulphate of ammonia. No internal or external symptoms of the disease develop and there is no bad opening of the bolls. The yields of *kapas* are greatly increased by the application of sulphate of ammonia to such soils.

It is possible that the fields, where the two adverse soil conditions mentioned above exist together, can be ameliorated by late sowing, coupled with the application of nitrogen. This is being investigated at present.

Late sowings of cottons in the Punjab, apart from being a remedy for the *Tirak* disease, appear to be a physiological necessity, as revealed by the growth studies made so far. June-sown crop appears to be better adjusted to the environment than the May-sown crop, and consequently, its efficiency for *kapas* production is greatly increased as compared with the efficiency of the early sown crop on normal soils. This point too is under investigation.

Scheme for improvement of Punjab-American 289F cotton. This scheme aims at purifying and improving the Punjab-American 289F/K25 cotton, which was evolved at the British Cotton Growing Association Farm some years ago and is a very popular cotton in parts of the Lower Bari Doab Canal Colony.

During the year under review, several single plant selections as well as F_1 hybrids from 289F/K25 × 289F/43 cross were examined and a large number of selections made.

Roguing of the general crop of 289F/K25 was carried out at the British Cotton Growing Association Farm to purify the present commercial crop with a view to improving it by judicious selection.

Agronomic experiments, viz. variety trials and a multiple-factor experiment involving varieties, spacing and small quantities of artificial manures were carried out, but as this was the first year of such experiments no conclusions can be drawn.

Root-rot scheme. During the year experiments were conducted to determine the effect of soil temperature on the incidence of the disease and it was observed that the incidence was reduced on lowering the temperature in the case of *R. solani* but not to any material extent in the case of *R. bataticola.* The progress of the disease was also observed to be checked under conditions of high humidity and low temperature. Cotton grown mixed with *sorghum* tended to show lower incidence, as *sorghum* appeared to reduce the air temperature and raise the humidity. An attempt was made to test the effect, on the incidence of the disease, of changing soil reaction (which is normally alkaline), by the addition of lime and sulphur. The results were, however, found to be negative. Cottons sown early in April and those sown late, after the middle of June, suffered least from root-rot mortality and the yield obtained from these sowings was quite satisfactory. If such sowing is supplemented with certain pre-sowing cultural operations, like ploughing, removing the diseased debris, manuring or heavy irrigations, the yield of early and late-sown

cottons is found to be much higher and the incidence of the disease reduced to a negligible degree in comparison with May-sown cottons.

The addition of certain fertilizers, such as potassium or calcium chloride, appears to help in reducing the mortality and increasing the yield.

Scheme for cotton Jassid investigation. The chief feature of the year was the extremely mild attack of the pest throughout the province. Comparative population of Jassids on different varieties of cotton, viz. Jubilee, 289F/43, 289F/K 25, 4F, LSS and 100F, was recorded by three methods. The largest number of Jassids (both adults and nymphs) were observed on 289F/K 25 and the least on Jubilee cotton. The highest Jassid population was recorded in the beginning of September on all the varieties, when it declined rapidly and continued low till the end of the season. Late-sown cotton was comparatively more infested than the early sown one.

The pest infests other host plants, besides cotton, such as *Hibiscus esculentus* (*bhindi*), *Solanum tuberosum* (potatoes) *Solanum melongena* (brinjals) and *Althea rosae* (hollyhock). *Bhindi* continues to be severely infested in spite of the presence of other hosts. Brinjals and potatoes help the pest in tiding over the period between two cotton seasons. The lowest Jassid population in the fields was observed in January, February and March.

Caged plants of Tanguis × U4 cotton were tested for resistance and the results showed that the insect could not do any damage to the plants when ordinary muslin cages were used, but the effect was disastrous with cages with thicker type of covers, thus showing that the resistance in cotton plants is associated with their vigour.

The Punjab clean-up scheme. During the year, a compact area of 500 square miles, comprising 183 villages in Lyallpur and Jhang districts, was selected for the removal of cotton stalks with *kudali* (a modification of Lantana *kudali* from Mysore). All other host plants were also carefully eradicated from this area. The effect of these clean-up measures on the incidence of the spotted bollworm was studied from June to December, and it was found that the pest was practically absent in the cleaned area during the period of growth of cotton between June and July. During August-December, the spotted bollworm population in the treated area was 2-3 times less in the case of *desi*, and 3-4 times less in the case of American cotton as compared with that in the uncleaned area.

A clean-up campaign was again organized, in 1938-39, to deprive the spotted bollworm of its food during January to May. These operations were repeated in the same 183 villages of Lyallpur and Jhang districts in which they were carried out last year. The actual removal of cotton stalks was started in January 1939, and by the end of March 1939, the entire area was cleaned.

CENTRAL PROVINCES. *Botanical scheme.* The chief feature of the year was the success which attended the cultivation and expansion of V 434 which again showed its superiority to all other types of cotton grown. There were some 63,700 acres under it during the past year—grown from seed supplied by or raised under the supervision of the Agricultural Department. There is reported to be a great demand for the seed of this cotton, not only within the province, but also from outside. Another important item of the work was the development and comparative trial on a field-scale of the four new strains of *Gossypium indicum*, viz. B 61, B 64, B 73 and B 90 on the various Government farms.

Besides being resistant to wilt, these possess fine long lint which is capable of giving the best spinning performance attainable in an Indian cotton. Late Verum was grown over an area of 10,000 acres in the east Berar and parts of the Central Provinces where the monsoon lasts till rather late in the season. No. 438 was again found suitable for the lighter types of soil. Improvement work on Buri cotton was continued. Of the three strains of Buri, 107, 84 and AK Special, 107 gave the best performance in the Burhanpur taluka.

Verum seed distribution and marketing scheme. During the year under report, the Agricultural Department distributed 4,231 *khandis* (1 *khandi*=784 lb.) of pure seed of improved strains sufficient to cover about 112,853 acres, against 4,233 *khandis* for 87,649 acres in 1937-38. A total of 5,482 bales of pure cotton were disposed of at an average premium of Rs. 43-7 on Broach and Rs. 55-10 on Oomras against 4,575 bales sold in the previous year at an average premium of Rs. 39-15 on Broach and Rs. 57-7 on Oomras.

Distribution and marketing of Buri 107 cotton in Burhanpur taluka. This scheme aims at introducing Buri 107—a selection from acclimatized *Gossypium hirsutum*—in the 30,000 acres now under mixed local Buri in the course of three years.

UNITED PROVINCES. *Botanical scheme.* This scheme was sanctioned by the Committee in January 1938 for a period of five years and was put into operation in August 1938. The scheme is concerned with the development of improved strains of Bengal cottons for the rain-fed and irrigated tracts of the United Provinces from the material collected in the course of the recent survey of cottons conducted in Rohilkhand and Bundelkhand and the investigation of the possibilities of growing long-staple cotton in the pink bollworm controlled areas.

During the year the crop suffered from scanty rains in some parts and incessant rains in others. The irrigated areas, however, produced average crops. The experiments at Cawnpore and Belatal failed entirely on account of heavy and protracted rainfall.

Amongst the eleven C 402 selections, one gave significantly higher yield over the standard type. Results of C 520 selections did not show any significant differences.

Extensive varietal trials of C 520, C 402, Malvi 1, Verum 438 and Perso-American were carried out under dry and irrigated conditions in the pink bollworm controlled and uncontrolled areas. These have shown the general superiority of C 520 and Perso-American at most centres and the unsuitability of Verum 438 and Malvi 1 at all centres. The results, however, cannot yet be regarded as being conclusive. Perso-American appears promising, if sown about the middle of May with irrigation in areas of deficient rainfall.

BENGAL. *Comilla cotton scheme.* During the year, 28 single plants were grown in progeny rows from the stock of last year. These were multiplied in different blocks, replicated six times and examined for their economic characters. A progeny of 18 single plants was selected from the bulk material of the previous year and randomized under two types of cultivation, one being the terrace system advocated by the Department of Agriculture and practised at the Rangamati farm, and the other the *jhum* system. The value of these selections under the two systems is being studied, and it is hoped that some useful results will become available next year.

HYDERABAD. *Botanical research scheme at Parbhani.* During the period, preliminary tests on 300 new selections of the medium-staple Gaorani and about 100 of slightly shorter staple were carried out at Parbhani.

The experiments on varietal tests carried out at Parbhani and at the variety testing stations at Latur and Madhol with Gaorani local and four improved strains, viz. Gaorani 3B-1, Gaorani 4B-5, Gaorani 6 and Gaorani 113, resulted in Gaorani 4B-5 and Gaorani 3B-1 giving a significantly higher yield than the local. Of the other two strains, Gaorani 6 gave almost equal yield, while Gaorani 113 gave even lower yield than the local.

Besides Gaorani 4B-5 and Gaorani 6 mentioned above, four new strains were tested against Gaorani-umri at Parbhani with the result that Gaorani 4B-5 was found equal to Gaorani 117 and both Gaorani 4B-5 and Gaorani 6 gave significantly higher yield than the four new strains.

The second series of varietal tests was conducted at the Government Experimental Farm, Parbhani, and at the Cotton Research Station, Parbhani, but none of the improved strains excelled the local in point of yield.

Twenty-one medium-staple strains were tested against the short-staple local variety at the Cotton Research Farm, Parbhani, with the result that five strains gave significantly higher yield than the local. Of the other four promising strains, two were found to possess a longer fibre and a higher ginning out-turn than the short-staple local variety.

At the Government Farm, Rudroor, Parbhani-American 1, Hyderabad-American 8 and Havri 3 (a Roseum selection) gave significantly higher yields than all the Gaorani strains included in the experiment.

During the year 3,120,000 lb. of seed of Gaorani 6 were distributed over an area of 200,000 acres in the Nirmal taluka of Asifabad district and the Madhol and Bilol talukas of Nanded district. As the crop suffered badly from heavy rains, the net area cropped was estimated to be only 110,000 acres. The production amounted to 5,300 bales, i.e. an average yield of only 65 lb. of *kapas* per acre. The entire produce was ginned, pressed and sold under state supervision, and it was estimated that the growers of Gaorani 6 realized Osmania Sicca Rs. 1,10,000 more than they would have done from the local variety. Nearly 4,415,000 lb. of pure seed were purchased by the Department of Agriculture for distribution in the current season in a compact block of about 275,000 acres.

Pink and spotted bollworm scheme. Observations on the incidence of the two pests on the cotton crop at the Main Farm, Parbhani, showed that the damage to the green forms by both the bollworms was rather low till the end of October. This low incidence, especially of spotted bollworm, was due to heavy showers of rain during the previous months. In November and December, a gradual increase in the percentage of damage by both the pests was observed, the damage being more in the late-maturing variety, Gaorani 12, than in the early maturing Gaorani 6. The crop was harvested in six pickings, the last being taken on 2nd January 1939. Due to abnormal weather conditions, the bulk of the crop was finished in the first four pickings. The last picking, which formed only 2 per cent of the total crop, contained 54 per cent damaged and 24 per cent useless locks. However, when this was mixed with the other pickings, the quality of the total crop was lowered. By a judicious fixing of the date of the last picking and by ignoring the small quantity of cotton in that picking, the clean-up measures can be given an earlier start and at the

same time the number of caterpillars that go into the resting stage in the soil can be reduced. The observations on the time of effective carry-over of pink bollworm through soil generally indicated that :—

(1) the pink bollworm caterpillars start going into hibernation in soil from towards the end of the cotton season,
(2) their number in soil increases if the plants are allowed to stand in the field for a longer period,
(3) more caterpillars are met with in the examination of soil made before the middle of April, and
(4) the variety of cotton, stand of the crop and the nature of the soil play an important part in the number of caterpillars going into the resting stage in soil.

Bollworm clean-up scheme. Due to a low carry-over of pink bollworm from 1937-38, adverse weather conditions in 1938-39 and markedly early maturation of the new crop, the attack of the pests on the 1938-39 crop was distinctly low in both the cleaned and untreated areas and showed only a little difference between the two tracts. The analysis of the ripe crop also gave similar results, the damage by bollworm being much less in the early than in the late-maturing crop. The clean-up work was carried out successfully for a second time. In addition to the difficulties met with in 1937-38, the unusual compacting of the soil in 1938-39, and the economic distress of the cultivators militated against a very early clean-up. In much of the area, the clean-up work was completed by the 30th of April. To overcome the inability of the existing type of blade-harrow to remove green plants effectively, a modified harro-blade was devised and given a preliminary trial, with the result that the green plants were removed more effectively than by the implement at present in use ; but further trials on an intensive scale are needed. An experiment to determine the effect of early and late clean-up on the hibernation of pink bollworms in soil was started. The first examination of soil in the early and late cleaned areas revealed but little difference in early and late cleaned plots, except in one locality, where the crop was removed late and the soil showed a greater hibernation. Further examination of soil in these localities is in progress. The ginning of all the *kapas* in the control area was completed before 30th of April and success was also achieved in the prevention of growing *bhindi* (*Hibiscus esculentus*) and, *ambadi* in the off-season. Also, a preliminary trial with different kinds of vegetable crops was carried out to determine their suitability as substitutes for summer grown *bhindi* and *ambadi*. *Palak, kulfa, chandanbatwa* and *guvar* were found to give the best results ; *kulfa* and *chuka* are likely to find favour with the farmers. The effect of the control measures on the incidence of bollworm attack in the forthcoming season will be studied. The investigation of the effects of the early and late clean-up on the subsequent infection and the yield of the new crop will also be taken up.

Scheme for inclusion of Northerns and Westerns cottons in programme of work of dry farming scheme at Raichur. The work during the year under review was carried out on the same lines as in the previous year with the necessary modifications suggested by the Committee. The following four experiments were under study :

1. manurial *cum* varietal experiment,
2. tillage experiment,

3. bunding experiment, and
4. observations to test the superiority of varieties.

Scheme for improvement of Kumpta cotton. The work done during the year consisted largely of properly conducted comparative tests with the most promising new strains, their parents and the two imported types, Hagari and Jayawant. Of the new strains included in the varietal tests, Raichur-Kumpta 15 gave a significantly higher yield and greater ginning out-turn than its sister strains, Raichur-Kumpta 19 and Raichur-Kumpta 27, and all these three strains were superior to Hagari and the local variety in respect of yield. Raichur-Kumpta 19 maintained the lead in spinning performance, the next in order being Raichur-Kumpta 15 and the local variety. Six strains of local Kumpta were found to be promising; Raichur-Kumpta 25 and Raichur-Kumpta 29 did well in the previous year also.

Seed distribution scheme. During the year 2,54,918 lb. of Jayawant seed were sown over an area of 21,706 acres and 2,520 lb. of Gadag No. 1 over an area of 300 acres, against 2,53,004 lb. of Jayawant over 20,032 acres and 10,941 lb. of Gadag No. 1 over 1,060 acres in 1937-38. The natural spread under Jayawant was 30,000 acres.

The Kopbal Cooperative Cotton Sale Society, which was started in 1932, continued to cooperate with the Agricultural Department in the production and sale of pure seed and the holding of auction sales. During the year, 750 *docras* of Jayawant *kapas* were sold by auction at a premium of Rs. 30 on Broach. At another auction 329 *docras* of Jayawant *kapas* were sold at a premium of about Rs. 20 on Broach.

BARODA. *Root-rot scheme.* This scheme which has for its object the study of the root-rot disease of cotton in Baroda and the production of strains resistant to it was sanctioned in July 1931 and came into operation in February 1932.

During the year K S progenies from the last year's material were tested for root-rot resistance in a glass-house. Crops like *bajra*, rice, sunn-hemp, *variali*, *tur*, which are usually sown mixed with cotton, were rotated with the latter and also sown in alternate rows with cotton to study their protective effect on the disease. The results are not yet available.

Scheme for survey of Goghari cotton. During the year the cotton crop in 83,746 *bighas* was surveyed. This showed a total calculated area of 121 *bighas* to be under Goghari mixture, i.e. 0·2 per cent of the entire area surveyed. The range of mixture varied from 1 to 2 per cent. Out of 8,986 cultivators in 120 villages, fields belonging to only 594 showed admixture of Goghari, in an area of 5,289 *bighas*. Propaganda work was continued along the lines of the past year.

The object of the survey has been well served; a sustained propaganda and careful field to field investigation coupled with the enforcement of the Cotton Control Act, 1935, have helped to check this menace to the reputation of the Navsari cotton.

Plant-puller propaganda scheme. During the year, the number of plant-pullers sold in Baroda and Navsari districts, was 2,767 and 1,750, respectively, and the area handled amounted to 162,000 acres and 334,373 *bighas*, respectively. The percentage of the uprooted area was 38 to 60 in the Navsari district against 24 to 80 in the Baroda district.

Scheme for improvement of Mathio cotton at Amreli. During the year, out of the 40 high-yielding Mathio selections with a ginning percentage of 35 and above and staple length of 18 mm. and above were grown in replicated progeny rows, and the best ten types, superior to ordinary Mathio in yield, ginning percentage, or fibre length were selected for further trials.

Replicated tests of seven varieties, C 520, N R, Jarila, Banilla, V 434, V 438 and Mathio, showed no significant differences between the yields of the important varieties, viz. C 520, Jarila, Banilla and Mathio. Owing to abnormal season, the yields were very poor and therefore of no comparative value. C 520 and Banilla ginned higher than Mathio but in spinning value Banilla and Jarila were found to be much superior to C 520, N R and Mathio.

Baroda (Navsari seed storage) scheme. During the year, 20,406 lb. of seed raised from pedigree seed were issued to A class growers for sowing over an area of 1,200 acres and 1,56,962 lb. to B class growers for sowing over an area of 7,000 acres. The produce of the improved seed was marketed through the marketing office at Surat. 1,787 bales of lint were sold at a premium varying from Rs. 1-10 to Rs. 10 per *khandy*, against about 559 bales sold last year at premiums ranging from Rs. 3 to Rs. 11 per *khandy*.

B D 8 cotton scheme. During the period the scheme has been in operation, 5,130 lb. of A grade seed, 18,760 lb. of B grade seed and 57,800 lb. of C grade seed have been distributed for sowing over an area of about 8,000 acres.

BIKANER. *Bengals cotton improvement scheme.* Selection work was undertaken in Cwn 520 to ascertain if its inherent defective germination can be improved. Two sub-strains of C 520 were obtained with better germination under field conditions, but they did not maintain their superiority during the year for some inexplicable reason. None of the selections from the local survey material was found to be superior to Cwn 520 in yield and quality. The first lot of material from Rohilkhand and Bundelkhand survey was examined during the last three seasons and two or three selections from it appear to be slightly better than Cwn 520 in yield, but not in quality. From the bulk trials in progress, the best will be selected for replacing Cwn 520. The results obtained so far, however, do not show much chance of a better quality cotton being found by selection from the local material. The cross between Cwn 520 and Bani has given the most promising breeding material for the improvement of quality and the best of the selections are being tried under replicated progeny row tests.

MYSORE. *Doddahathi cotton scheme.* Observations made on the incidence of disease on different varieties at the Irwin Canal and Hebbal farms showed that the incidence differed with each variety; those that appeared resistant under irrigated conditions proved susceptible under dry conditions. MA2 and Co 2 were found to be less susceptible than other varieties tested. The study of the effect of different seasons on the disease revealed that the incidence varied from year to year even for the same variety. October and early December were recorded to be the peak months of the disease for all the varieties during the year. Observations made during the last two seasons showed that the date of sowing has an important influence on the final yield of the crop. In the varietal tests laid out in six randomized blocks with seven varieties, MA II gave significantly higher yield than the others. In demonstration plots, MA II, as a dry crop, gave a very high yield with a total rainfall of 5 in. This strain withstands the attack of red leaf to a greater degree than others.

This disease-resistant character appeared to have been inherited by it from its *peruvianum* parent. Several crosses between *G. peruvianum* and promising *hirsutums* and Sea Island will be made during the next season. During the year, a few fresh crosses and a large number of back-crosses were made with a view to combining, if possible, the desirable characters of two or more strains into one.

(c) Research on cotton technology

Research on cotton technology was continued at the Committee's Technological Laboratory at Matunga. A noteworthy feature of the year was the steady increase in the activities of the Laboratory falling within the scope of the Testing House which was inaugurated in 1937. Six hundred and thirty-five routine samples were received for tests during the year, representing an increase of 17 per cent over last year's figure. The increase was most pronounced in the case of agricultural samples and samples for technological investigations.

In connection with the agricultural samples, a test which deserves special mention is that relating to comparative tests on Umri-bani and Gaorani 6 to find out whether Gaorani 6 can replace Umri-bani as a standard Indian cotton. It was concluded that, if considerations of yield and ginning percentage permitted, cultivation by the farmers of Gaorani 6 instead of Urmi-bani would he a better paying proposition.

A large number of samples of lint, yarn and cloth were received for tests from various firms. A sample of bleached yarn, discoloured by brown stains, was received from a firm to find out the cause of these stains and the ways and means of removing them. The tests carried out showed that the stains were due to the yarns having come into contact with rusty iron, either in the kier or in the packing cases and that they could be removed effectively by a chemical treatment. A sample of cloth in which certain insects of a boring type had made holes was received from a mill and a formula for a protecting varnish was supplied to the mill, together with suggestions for storing the cloth in such a way as to obviate or greatly reduce the risk of similar damage. In connection with the investigation on the absorption of dyes by Indian cottons, a calorimeter employing the use of photo-electric cells has been designed at the Laboratory, and during the year two samples of cotton sent by a mill were tested with the help of this instrument to find out their absorption for direct dyes. Measurements of this type are important to the mills because the dyes being relatively more expensive, some saving can be effected by using cottons which, other factors being equal, absorb less dye than others.

Practical spinners are often confronted with the problem of predicting the test of cotton for a specified count from the known results of a count into which it has been spun. With the help of the data available at the Laboratory, this problem has been successfully solved by working out a suitable formula.

Introduction of improved varieties of cotton

The table below indicates the progress made in the introduction of improved varieties of cotton in the various provinces and states during 1938-39; the actual area under these varieties is probably higher than given in the table, as complete information for area under natural spread is not available.

Area under improved varieties of cotton

Name of province or state	Variety of cotton	Area (in thousand acres)	
		1938-39	1937-38
Bombay	1027 ALF	80	92
	Jayawant	499	402
	Gadag I	148	125
	Banilla	45	81
	BD 8	14	6
	Jarila	13	..
Madras	Cambodia	207	244
	N 14	10	4
	H 1	238	223
	Karunganni (G7, AK and K1)	162	205
Punjab	*Punjab-American—*		
	4F	993	1076
	289F and 289F/K 25	160	126
	289F/43	125	122
	LSS	200	116
	Mollisoni	755	981
Sind	Sind-Sudhar	224	269
	Sind-American—		
	4F (and unspecified)	362	380
	4F 98	59	68
	Sea Island and Boss III	*	1
	27 WN	225	250

* Less than 500 acres.

Area under improved varieties of cotton—contd.

Name of province or state	Variety of cotton	Area (in thousand acres) 1938-39	1937-38
Central Provinces and Berar	Verum	196	137
	Buri	27	3
United Provinces	C 402	2	3
	C 520	34	29
	A 19	2	13
Indian states			
Bombay states	1027 ALF	157	142
Baroda	1027 ALF	50	50
	BD 8	5	1
Punjab states	Punjab-American strains	312	337
Khairpur	SA 4F (and unspecified)	11	15
	27 WN	35	74
Hyderabad	Gaorani 6	250	40
	Banilla	*	1
	Parbhani-American	2	*
	Jayawant	52	23
	Gadag I	5	5
Central India and Rajputana	Malvi strains	4	7
	Total	5,663	5,651
	Percentage of the total area under cotton in India.	24	22

* Figures of improved *desi* (Mollisoni) cotton are not available.

Cooperative cotton sale societies

The number of cooperative cotton sale societies working in the Bombay Province during 1938-39 was 34 as against 30 in 1937-38. The total quantity of *kapas* sold was 6,56,433 maunds, the price realized being Rs. 38,72,003. In

the Madras Province, 21 cooperative cotton sale societies dealt in cotton as against 16 in the previous year and the total value of cotton handled by them was Rs. 20,53,480. The Tiruppur Cotton Sale Society supplied pure seed of Co 2 cotton to ryots over an area of 4,000 acres. It also took on lease a factory and ginned 9,762 *pothies* of *kapas*. The society produced 13,138 bags of pure seed worth Rs. 57,520. Only one cooperative *adat* society dealing largely in cotton worked in the Central Provinces and Berar as against two in the previous year. Both ginned and unginned cotton of the aggregate value of Rs. 15,409 was handled by it. Eighteen cooperative commission shops in the Punjab dealing largely in cotton handled, 3,03,302 mds. of *kapas* of the value of Rs. 18,16,300 as against 20 which handled 2,62,394 mds. of the value of Rs. 16,30,853 in the previous year. In the Baroda State 30 cotton sale societies worked during the year under report as against 18 in 1937-38. They handled 9,575 *bhars* of cotton of the aggregate value of Rs. 7,08,038. Moreover, five credit societies of Karjan taluka ginned 734 *bhars* of cotton and realized Rs. 55,337. The Damnagar Cooperative Bank and Kodinar Cooperative Banking Union sold collectively 465 and 340 *bhars* of cotton of 14 and 29 societies respectively. A cotton marketing office also was opened at Surat in the season to sell and get better prices of lint of the cooperative societies and agriculturists of Navsari district. In the Mysore State, there were no sale societies which dealt exclusively in cotton but one credit society at Maradihalli in Chitaldrug district supplied to its members 500 and 50 maunds of selection 69 and H 190 cotton seed respectively. It collected 13,202 mds. of seed cotton, and 141½ mds. of lint cotton and got them ginned and sold 254 bales of cotton. The Department of Agriculture was supplied with 6,658 mds. of cotton seed.

4. Sugarcane

The area planted with sugarcane has been widely varying in recent years depending on various factors, the chief of which is the price which the grower has been able to obtain for his crop. Another major factor has been the prevalence of pests, diseases and other adverse conditions like floods which affect the growers' enthusiasm for the crop and at times even delimit the material available for seed.

During the year the total sugarcane area in India was 3,113,000 acres, almost the same as about the early thirties, before the effect of protection became noticeable. This represents a fall by 30 per cent from the 1936-37 crop, the peak year both for cane acreage and sugar output. Besides this shortage in area, both the acre-yields and recovery were markedly low during the season on account of diseases and floods in the two major sugarcane provinces of India, viz. the United Provinces and Bihar. This resulted in the crushing season in both these provinces being one of the shortest on record.

That, in spite of all these adverse circumstances, the Indian white sugar output was over eight times of what it was before protection was brought in, indicates (1) the appreciably increased yields from the improved varieties and (2) the great development in the industry as the result of protection and the availability of raw material through increased acre-yields.

Results of sugarcane development during the year indicate the variety as the central factor in sugarcane improvement work as elsewhere in the world.

One important lesson to be drawn from the experience of this and recent years is the need for avoiding the wide fluctuations in cane area and acre-yields from season to season. It is clear that for the proper development of the industry the quantity as well as the quality of available raw material—both from good and bad seasons—needs to be stabilized as far as possible.

Central Government activities

IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI. It is well known that the renaissance of the Indian sugar industry—converting it from a country importing white sugar to the tune of a million tons into one which during the crop year 1936-37 produced a surplus of roughly a quarter million tons—resulted from two factors, viz. (1) the availability of raw material resulting from improved canes which, besides giving greatly increased yields, also showed themselves responsive to better agricultural treatment, and (2) the very substantial tariff protection. Most of these improved canes were the result of the activities of the Imperial Agricultural Research Institute at New Delhi through its substation at Coimbatore. Over the bulk of the Indian area, the term 'improved cane' is now practically synonymous with Coimbatore cane.

Coimbatore Breeding Station. The Coimbatore Breeding Station continued its proved activities and recorded advances in the following directions :

(1) There was a further extension in the range of parents available for crossing with the sugarcane ; certain of these included weeds like *Imperata* and *Sorghum halepense*. This work is intended to widen the range of variation and try and work into the new productions characters not available in the genus *Saccharum*.

(2) The breeding of the thick type of canes yielded further economic results, certain of the resultant productions finding use even under subtropical conditions. The breeding of the subtropical types recorded advances in the evolution of types to suit special conditions. Cos 419 and 421 have shown usefulness as parents in further breeding, while Co 396 as an 'early' cane in the Punjab, Co 421 as a heavy yielder in subtropical India and Co 356 (a sugarcane *Sorghum* hybrid) as a midseason cane in Bihar deserve mention.

(3) On the cyto-genetic side, the somewhat peculiar phenomena of inheritance in sugarcane have been traced to the polyploid nature of most sugarcane parents and irregularities in chromosome pairing during meiosis. Other useful results include photo-periodism experiments which successfully bridged the time gap between parents (it is desired to cross with each other) by over a fortnight and studies on the inheritance of anatomical characters in the rather wide range of hybrids with *Saccharum*.

Chemical investigations. The Chemical Section of the Institute carried out extensive investigations on the chemical constituents of sugarcane juices with the object of elucidating the factors responsible for colour and keeping quality of *gur* (raw sugar). Preparation of activated carbon from material available as by-products of agriculture and its use in the preparation of *gur*, first developed by Rao Bahadur Viswanath at Coimbatore, is being increasingly adopted—sometimes with modifications—in various parts of the country. It has led, among others, to a company being floated in Bengal for the manufacture and sale of such carbon.

Insect pests. A scheme for research on the insect pests of sugarcane with the object of taking stock of results from all the provinces and correlating them was in progress under the Second Entomologist at New Delhi now working entirely on sugarcane insect pests. In the laboratories at Delhi and its sub-stations at Coimbatore and Karnal data were recorded listing such pests, their life-histories, their natural enemies and their bionomics. The regional survey of sugarcane borers and other pests throughout the country (represented by as many as 17 regions) was initiated during the year.

Biological control of insect pests. Perhaps the first attempt in British India at biological control against the sugarcane stem-borer was carried out in Orissa at Cuttack by the mass liberation of *Trichogramma minutum* with apparent beneficial results. A similar attempt with regard to *Pyrilla* was made in a private farm at Pilhera in Meerut district. A correlation was established between the hardness of mid-rib in sugarcane leaves and its resistance to top-borer.

Mosaic and other diseases. Work was in progress on mosaic and other maladies like red-rot, wilt and smut. It was found that Co 313, one of the popular canes in subtropical India, showed a high degree of tolerance, the decrease in yield being only about 10 per cent even in fields with 100 per cent infection. It was found that natural transmission of mosaic varies considerably from station to station and that, fortunately, certain of the existing important sugarcane research stations like Pusa, Shahjahanpur, Karnal and Lyallpur are situated in regions of slight natural transmission. Evidence is also available to indicate the existence of different strains of mosaic virus. It was found that when mosaic-affected canes were planted the percentage of stools free from the disease was greater when the setts were taken from the middle portions of the canes. With the organization now available it will become increasingly possible to assay the reaction of new canes to certain of these diseases almost simultaneously with their selection.

UNITED PROVINCES. Sugarcane research in this province was carried on at the main station at Shahjahanpur and the subsidiary stations at Muzaffarnagar and Gorakhpur. Experiments to watch the effect of ratooning, financed partly from provincial and partly from the Imperial Council of Agricultural Research funds, were in progress at Kalai and Aligarh.

Co 527 was found to be the best 'early' cane and Co 421 the best among the 'medium and late' canes. Among good ratooners are Co 313 in the 'early' series and Cos 331, 312, 421 in the 'medium and late' canes. Certain of the seedlings selected from seed germinated and grown at Shahjahanpur have shown sufficient promise to be in a stage for final trial. A comparative mill trial of Co 312 and Co 421 showed the superiority of the former, whereas in the previous year Co 421 was superior apparently because of its greater freedom from the *Pyrilla* pest.

Among agronomical findings, the following deserve mention :—

(1) Nitrogen alone has significant effect on cane yields showing that the soils under experiment were not lacking in potash or phosphates.

(2) Sunn-hemp plants for green manure are best ploughed under when 50 to 75 days old and as whole plants.

(3) In yield of cane, molasses as manure gave the highest results followed by departmental mixture No. 2, castor-cake, ammonium sulphate, calcium

cynamide, press mud, farm compost, municipal compost and farmyard manure.

On the physiological side, experiments were in progress to study the inter-relationship between nitrogenous manuring, water-duty, date of sowing and varieties, and the effect of climatic conditions on growth. Pot-culture studies were in progress to study the effect of different components such as nitrogen, potassium, phosphorus, iron and boron.

Experiments were in progress to study the effect of ratooning on quality and yield of cane and the carry-over of diseases and pests with the object of arriving at definite conclusions about the adoption or rejection of this practice. A scheme of entomological work financed by the Imperial Council of Agricultural Research was in progress, with headquarters at Muzaffarnagar. The year was comparatively free from insect pests and preliminary ideas have been obtained as to the climatic conditions which restrict their appearance. Trashing, removal of growing shoots and bagging were tried to control *Pyrilla*. A new type of striped borer was recorded from Dehra Dun.

BIHAR. Perhaps the most striking and desirable feature in the sugarcane work of this province is the close liaison which the research organization in the province has been able to establish both with the growers and the factories. A similar feature in Java is widely accepted as chiefly responsible for the very satisfactory results in that country.

This province was the first to adopt mill tests of improved canes as the only reliable index for their distribution and this has now become a standard practice. There has been a great increase of such tests during the year. Besides such mill tests, both varietal and manurial tests have been inaugurated in growers' plantations. Such collaborative experiments are very valuable because they eliminate the personal factor in the results obtained and the variety or the treatment records its performance from tract to tract all over the province.

Besides Co 299 and Co 508, Co 395 showed promise as an early cane. Co 356 is taking a definite place among the midseason canes from its performance in factory tests. One of the seedlings raised in Bihar, viz. BO 4, showed promise of usefulness and Co 419 as a plantation cane. Co 331 proved superior to Co 213 in South Bihar.

The manurial tests brought out the superior value of manuring with castor-cake and the molasses trials showed that even when high yields were obtained from their application the economic returns were negative. Press-mud cake was indicated as a promising manure to be applied to canes. Results of practical value were registered on field treatment to stamp out red-rot, the removal of whole stumps of affected canes and milling them for juice being indicated as a useful measure of protection. Treatment and growing of seed material to improve germination and the study of the relative dryage of cane varieties during transport, were other lines of work which had a direct practical application to the needs of the industry.

PUNJAB. Growth conditions for the crop in the Punjab are perhaps the most difficult of any cane area in India. This is the province most affected by frost, with the result that the period available for growth is easily the shortest of any province. The difficulties in the situation are evidenced by the fact that the factory at Sonepat was shifted to a locality in the United Provinces.

for bettering its financial position, and this in spite of the continued Government assistance to it for several years since its establishment. The Punjab Agricultural Department has carefully gone into the matter and made a detailed survey of the sugarcane crop and its composition in and around Sone pat. It has come to two important findings which should be of use in the future development of white sugar industry in the province. It was found that though the yield of cane was satisfactory in the Sonepat tract the comparatively higher ash contents in the juice combined with the slightly lower sucrose values were responsible for the difficulties experienced by the Sonepat factory. The carbonization process is likely to be more suitable to the Punjab conditions than the sulphitization process.

In spite of the obvious climatic difficulties as explained above, the spread of improved canes showed satisfactory progress both on account of their patently higher yields and the manner in which their spread was pushed on with the sugar excise grant and with funds made available through local Deputy Commissioners. Such funds were employed for meeting transport charges in the movement of seed material from one tract to another within the province.

Perhaps the most outstanding achievement in varietal work is the selection of Co 396 as 'early' cane. It is so early that, besides permitting crushing right at the beginning of the *gur* season when prices are relatively high, it enables the compressing of a three-year rotation into two years, an advantage of great agricultural value, particularly with the small-scale sugarcane farms very common in the province. Co 421 is steadily gaining an upper hand over Co 312. On the agronomic side, the following findings deserve mention: (1) very satisfactory results are obtained with sowing at 40,000 setts to the acre two feet apart followed by ridging on the break of the south-west monsoon and (2) a combination of equal quantities of farmyard manure and of artificials or organic manure like *toria*-cake are satisfactory.

BENGAL. Though the season for cane started well, disastrous floods during the later stages greatly lowered acre-yields and curtailed supply of available planting material for the next season. There was an increase in the number of sugar factories in the province.

Cos 381, 281 and 508 crushed in the order given have shown the possibilities of starting crushing even from November. The standard cane for the province is Co 213 and an attempt to find canes superior to it have brought out Co 331 and Co 421 as the likely ones; the former possesses a better field habit and the latter gives higher tonnage.

BOMBAY. This is one of the provinces in which the shortage of the season crop in the United Provinces and Bihar showed its repercussions in the shape of high *gur* prices. The effect was felt in spite of the slight increase in the production of sugar within the province itself. The sugarcane research in the province was centred in the research station at Padegaon financed by the Imperial Council of Agricultural Research.

The varietal changes in this province are interesting. In the days of Manjri, Pundia was the unchallenged cane of the tract. Two Java canes—POJ 2878 and EK 28— and Co 290 showed their suitability under plantation conditions and the cane Co 419 is gradually taking the dominant place in the sugar industry of the province at the present time.

The varietal tests during the year showed Co 426 as giving higher returns than either Pundia or POJ 2878. It was found to be a closer substitute to Pundia than the other introduced canes, both from its comparative softness and relative freedom from flowering.

Other work in progress included (1) soil physics studies which have given a clue for dealing with at least one type of *chopan* (alkali) soils, (2) the finding of definite soil exhaustion from the growing of improved canes without adequate and manuring and (3) the optimum interrelationship between water and manure for Pundia and POJ 2878. Varieties Cos 419, 413 and 421 have shown usefulness in *chopan* soils.

MADRAS. Sugarcane research work in the province was carried on in the two Imperial Council of Agricultural Research stations at Anakapalle and Gudiyattam and the provincial stations at Palur and Samalkot.

Co 419 was easily the winner at all the stations recording highest yields in comparative trials. One minor defect of the cane is its tendency to snap with high winds, while its tolerance to water-logged conditions is an asset of great value in the paddy areas of the province. In the preliminary trial plots, Co 527 showed the greatest promise. Other canes of promise included Co 381 and Co 508 as 'early' canes and Co 421 for tonnage.

Experiments on the different methods of propping and wrapping gave insignificant differences both between the methods themselves and with regard to the practice in the matter of yields. In quality, however, canes propped with wire gave uniformly good quality juices. Planting setts in deep trenches showed some use against lodging, while no difference was recorded between the application of mauure to the cane crop all in one dose just before the monsoon or distributed in more than one dose. In the Palur tract Co 281 was popular as, in spite of its comparative low yields, it was markedly early and resistant to water-logging. On account of this latter characteristic, this cane is getting popular even in parts of the Tanjore Cauvery delta.

ASSAM. Work on sugarcane in the province was carried on partly from the Imperial Council of Agricultural Research and partly from provincial funds. The standard variety in cultivation is POJ 2714 and tests were in progress to obtain an improvement on this cane. Co J 1, one of the seedlings raised at Jorhat from fluff received from Coimbatore, proved the most promising with Co 318 as a possible second. Co 419, already distributed to the growers, was found to be a little later in ripening than POJ 2714.

Manurial and cultural experiment showed (1) that 3 ft. spacing was the most suitable for thin canes and 4 ft. for thick canes, and (2) that 300 maunds of cowdung cake (with additional oil-cake) was the most remunerative kind of manuring for the cane crop.

ORISSA. The main sugarcane improvement scheme in the province consisted of the distribution of seed of improved canes and ammoninm sulphate free to growers with the object of spreading the new canes in cultivation. A private grower has successfully been induced to lay out an area of 15 acres under the departmentally recommended canes for the supply of seed.

A large number of seedlings—over a million—from as many as 48 varieties has been raised for propagation and study on the Cuttack farm.

MYSORE. Sugarcane research work in the state was carried on both at Hebbal and at the Irwin Canal Farm. Certain of the new HM seedlings and

Mys-ray canes were in various stages of multiplication and selection and some of these are showing promise of usefulness. HM 320, which is popular in Mysore, was successfully crossed with POJ 2878. Over a thousand buds from 21 varieties were irradiated with varying doses of X-ray.

Nitrogen being the largest plant-food requirement for sugarcane, experiments were laid down to ascertain the optimum dose, the best time of application and the most economical mixture to use. Economic response was recorded from manuring up to 500 lb. of nitrogen per acre both at Hebbal and in the Irwin Canal Farm. Beneficial results resulted from the application in small doses within the first 16 weeks. Application of potash showed beneficial results in areas that had been repeatedly cropped with cane. Other investigations included those on type of furnace and the preparation of *gur*. Use of activated carbon gave promising results.

HM 320, HM 602 and HM 607 among the older canes are popular. A medium cane, HM 661, gave high yields in small-scale trials. Two canes bred at the Irwin Canal Farm, viz. IC 25 and IC 28, are promising.

HYDERABAD. The scheme sanctioned by the Imperial Council of Agricultural Research was started in October 1938 and as such a full year record is not yet available. The work is centred at the Rudrur Experimental Farm, and selection of canes with reference to local conditions is in progress.

BARODA. The work was carried on at Vyara and many canes are in different stages of trial and selection. Cos 417 and 419 out-yielded the standard POJ 2878 both in tonnage of cane and *gur*, and Co 421 is among the canes of promise.

TRAVANCORE. Though the area in the state is comparatively small, it would appear capable of expansion in view of the unfailing supply of water in certain localities. The experimental station at Alwaye was converted into a purely sugarcane farm during the year. POJ 2725 is considered the most suitable at the moment and many other canes are under trial.

COCHIN. A large number of varieties were undergoing trial in the Ollukara Central Farm.

Introduction and spread of improved sugarcanes

The spread of improved sugarcanes in the country, which has been phenomenally rapid as compared with that of other crops, possesses certain interesting and instructive lessons both to crop-breeders and agricultural propagandists. The more important of these are mentioned below and as these corroborate certain findings of the Royal Commission on Agriculture in India, the paragraph numbers of the Commission Report are indicated in brackets.

It was not till indigenous parents—in the shape of wild *S. spontaneum* in the present case—were employed that anything like real success was achieved in the breeding of types suitable for Indian conditions (Para. 99).

The easiest spread in cultivation as improved types have been of those which scored in yield without at the same time involving much alteration in the existing agricultural practices. The easy and almost effortless spread of the Coimbatore types as compared to that of the once partially popular Java cane S 48 in the United Provinces which needed a special method of growing is an instance in point (Para. 100).

Demonstration of the performance of new canes in the grower's own fields and under his own conditions has proved the best method of propaganda for a

new type. The resistance of Co 205 to water-logging in the Punjab and of Co 244 to poor agricultural conditions in the United Provinces was first discovered in the growers' fields and a rapid spread followed in consequence (Para. 100).

In the absence of private agencies for stocking and distributing seed material, the agricultural departments in the country have been responsible for the distribution of new canes to the growers either from their own experimental stations or from private plantations under their partial control. Agricultural exhibitions and demonstrations at fairs and festivals, the running of an agricultural week in certain of the experiment stations, the free distribution of seed material and in some cases manure as well, the development of intensive cultivation round tube-well areas in provinces like the United Provinces (such areas receiving the special attention of the Agricultural Department) and the stimulus created by the demands from newly started sugar factories and last, but not least, the appreciably higher yields from the improved types, have all contributed to the rapid spread of the improved canes in the country. During the year under review, the area under improved canes was about 77 per cent of the total cane area in the country.

Work done at sugarcane factory farms

The owners of factories having realized the importance of the quality of sugarcane supplied to the factories, a few of them have started sugarcane farms, where experimental work on various aspects of cultivation, manure and suitability and adaptability of different varieties is being carried out. Although this kind of work has not grown in volume, considering the number of sugar factories, this small beginning augurs well for its future development.

In Southern India, especially the Bombay-Deccan, Mysore and Madras, the factories crush cane grown on their farms alone and a beginning has been made elsewhere in India by a few enterprising factories in establishing small farms as a nucleus for the work of testing new varieties.

In response to enquiries, eight factories were able to send their reports and the following is a short summary of the work carried out at those factory farms in 1938-39 :—

1. The Motipur Sugar Factory, Motipur, Bihar :

   Cultural : Subsoiling is done with tractors ; flat planting (Pusa system) is practised in rows 3 ft. apart ; planting is done from 15 January to end of March ; in light sandy soils planting is done in October.

   Manurial : The formula of the Agricultural Department, i.e. 40 N+50 P_2O_5 (in the form of castor-cake and superphosphate), is used ; molasses as manure in a dose of 200 mds. gave increased yields, but is not economical due to heavy labour charges in its application.

   Varietal : The major varieties planted are Cos 299, 313, 210, 213, 301, 331 and POJ 2878 ; of these Co 299 and 313 are early ; Cos 210, 213, 301 are midseason and Co 331 and POJ 2878 are late.

2. Harinagar Sugar Mills, Ramnagar, Bihar :

   Cultural : Dry planting is done in furrows 2½ to 3 ft. apart and the land is then made flat by *hengas*.*

* A term used in North Bihar for the wooden plank meant for levelling ploughed land.

Manurial: Trials with potash on the yield of cane and sucrose content did not show any definite result in favour of potash manures.

Press mud and molasses applied in a dose of 50 to 350 mds. per acre along with castor-cake gave increased yield, but the increase was hardly commensurate with the cost of handling and molasses as manure would thus appear to hold little promise.

Varietal: Co 213 is the chief variety. Others on trial are Cos 210, 299, 313, 371, 421, BO 4 and POJ 2878. Next to Co 213 stand two others, namely, Cos 313 and 331.

3. Saraya Sugar Factory, Sardarnagar, United Provinces:

Varietal: Work on determination of the yield of selected varieties has been carried on during the last four years; most of the Co varieties and POJ 2878, 2883 and EK 28 have been tested; the results have shown that Co 213, which was the main variety in 1935-36 is now being replaced by Co 299 which has been found to be superior. The other promising canes are Cos 331, 393, 370, 313 and 350; the variety Co 285 had to be discarded as it had high fibre and low sucrose content.

4. Pioneer Sind Sugar Mills, Mohattanagar, Pritamabad, Sind:

Cultural: October planting has given 25 to 30 per cent more yield than February sowing, but this result cannot yet be said to be conclusive; the distance between furrows is 2¾ ft. as 2 ft. was found to be too narrow for inter-cultural operations.

Manurial: Ammonium sulphate *plus* fish manure has given the best results.

Varietal: The varieties tested are Cos 312, 331, 419 and 421, of these Co 312 has been found to give the best yield, but has less sucrose than Co 331; Co 421 and 419 have failed.

5. The Ravalgaon Sugar Farm, Ravalgaon, Bombay:

Manurial: Trials using POJ 2878 in *adsali* planting, with heavy doses of manure resulted as follows:

Treatment	Area in acres	Average yield of cane per acre Tons
4 tons of oil-cake, with 900 lb. of ammonium sulphate	38·8	74·5
3 tons of oil-cake, with 675 lb. of ammonium sulphate	42·26	70·5
Normal dose 1¼ tons of oil-cake, with 562½ lb. of ammonium sulphate.	335	50·0

Varietal: Varieties planted are Cos 349, 360, 290, 419, POJ 2878, and EK 28; of these EK 28 has been discarded; Co 419 has given good yield and sucrose equal to POJ 2878 and is therefore replacing Co 290 which has lower sucrose content; Co 349 is a good cane but has poor sucrose and is liable to be attacked by the smut disease.

6. Marsland Price, Kalamb, Bombay:

Cultural: *Adsali* planting in October resulted in increasing the yield by 5 to 9 tons cane per acre over the November planting, using Cos 419, 413, 290, 407 and 408; but there was no difference in the case of POJ 2878, EK 28 and Co 360.

Manurial: High doses of nitrogen of 200 to 400 lb. in the form of groundnut-cake and ammonium sulphate, using POJ 2878, have been tried with the result that increased yield has been obtained with increased dose of nitrogen, but this increase is little in the case of 300, 350 and 450 lb. of nitrogen.

The effect of phosphatic manures on the growth and maturity has been tested with doses of 50, 100 and 125 lb. of P_2O_5 in the form of double superphosphate, along with the usual dose of nitrogen; the variety POJ 2878 was used. The addition of phosphate did not give any rise in purity and the tonnage yield was found to decrease with addition of phosphates.

Varietal: POJ 2878 and Co 290 are the most important varieties.

7. The Phalton Sugar Works, Phalton, Bombay:

Cultural: The number of setts for good yield has been found to be 10,000 per acre and the distance between furrows is 3½ ft.

Manurial: The *chopan* and silty loam soils did not respond to addition of potash manure and hence potash is not required in these soils. The application of superphosphate did not hasten the maturity.

Varietal: POJ 2878, Co 419 and Co 290 are the main varieties, POJ 2878 in *adsali* planting gave 52 tons per acre; Co 419 gave 45 tons per acre, Co 290 appears to be better suited to water-logged and salty lands than Co 419.

8. The Kolhapur Sugar Mills, Kolhapur, Bombay:

Cultural: Dry planting in furrows gave better germination; planting is done from August to November and in furrows 3½ ft. apart. The seed rate of 12,000 setts per acre has given the highest economic yield.

Manurial: Green manuring with sann is followed by 7 cwt. of ammonium sulphate and 10 cwt. of groundnut-cake and this dose is found to be the best; the combination of N. K. P was used but was not found to be superior.

Varietal: The chief varieties are POJ 2878, EK 28, Cos 290 and 419 and HM 89; of these EK 28 has given the highest yield of sucrose in mill trials; Co 419 is an early cane and has given the highest yield and sucrose per acre; Co 402 is late and stands next and HM 608 stand next in order.

5. Jute

The yield of the 1938 jute crop was estimated at about 95 lakhs of 5-md. bales, of which about 90 lakhs were received into Calcutta. Earlier estimates had indicated well over 100 lakhs but early floods caused considerable damage. The official forecast, issued in September 1938, was 67 lakhs. Following confirmation of the reports of damage caused by flooding and an order for 200 million sandbags placed in January 1939, there was a sharp rise in raw jute

prices. Between December 1938 and May 1939, the price of Jat Middles rose from Rs. 32 to Rs. 45 per bale, but as the growers had disposed of most of their jute by December they did not, in general, benefit from this rise.

The end of the year under review saw the completion of the Indian Central Jute Committee's Agricultural Research Laboratories at Dacca and of the recruitment of the staff. During the last few months of this period—March to June—the Jute Specialist was able to proceed with the field work necessary in connection with the experiments that had been planned. Replicated plots were sown for the study of the effect of manurial treatment upon the incidence of chlorosis and insect and fungal attacks. Sowings were made for the growing on and observation of the various strains of jute which have been produced by the work of the Department of Agriculture, Bengal. Other sowings included plots for the investigation of the influence of depth of flooding on the development of rooty fibre and of the density of crop-stand upon yield and quality.

The Technological Research Laboratories of the Indian Central Jute Committee, situated at Tollygunge, were in full working order by September 1938, and recruitment of staff was practically complete. The equipment and accommodation provided have proved very suitable for the objects in view. In the spinning laboratories rapid progress was made with the important task of working out standard methods of spinning representative yarn samples from small samples of fibre. It has been found possible to obtain sufficient yarn for all the necessary physical tests from as little as ten pounds of fibre. The strict control of conditions and procedure throughout the process ensures that the results are reproducible. Alongside the spinning and yarn tests, a physical and chemical examination of the fibre has been carried out in accordance with the programme of seeking correlations between spinning quality and the measurable characters of the fibre. The mesh-like structure of the fibre-system in the jute stem has proved of great importance in connection with measurements made on the fibre and it clearly has a close relation to spinning behaviour. Good progress has been made in the collection of books and information for the library, which it is aimed to make of the greatest possible use to all jute interests.

In June 1938, a Jute Census Committee was set up on which the Government of Bengal and the Indian Central Jute Committee are equally represented. This joint committee met four times during the year and finally approved a programme in connection with work on the 1938 crop which involved the complete enumeration of jute plots in nearly 700 square miles and a random sampling survey in over 2,500 square miles of important jute-growing areas in five districts. It is anticipated that the results of this work will give very useful information as to the best size of grid for use in a random sampling survey and enable reliable conclusions to be drawn as to the number of grids per square mile which are necessary to give an estimate of the required accuracy. It will also give valuable information as to the costs of random sampling surveys.

The Indian Central Jute Committee's marketing enquiry staff have completed their outside survey and good progress has been made in compiling a report from the information and the enormous mass of figures collected. This will cover the conditions governing the preparation of 'loose-jute' for sale and its marketing and transport to Calcutta mills, markets and baling houses. The Committee's monthly *Bulletin* was published regularly and there is evidence that its usefulness is widely appreciated.

The work of the Indian Jute Mills Association's Research Department has continued. In addition to confidential reports issued to its members it has published a valuable summary of information on the moisture relationships of jute and a paper on the swelling behaviour of jute fibres. It has continued to supply its members with abstracts of literature of interest to the industry. It is satisfactory to record that close cooperation between the Indian Central Jute Committee and the Indian Jute Mills Association has been maintained. This has included, in addition to work on the research programmes, the collection of information regarding the possible competition of jute substitutes, such as sisal and roselle, and regarding the threat to the industry by the extension of the bulk-handling of cereals and other products.

6. Other fibres

Sunn-hemp (*Crotalaria juncea*)

Exports of Indian hemp in the year under review declined to 816,000 cwt. valued at Rs. 72 lakhs from 830,000 cwt. valued at Rs. 74½ lakhs in the preceding year. Shipments to Belgium and the United Kingdom, which between them took about 56 per cent of the total quantity, exported in 1938-39 amounted to 257,000 cwt. and 205,000 cwt. as against 236,000 cwt. and 232,000 cwt. respectively in 1937-38. Exports to France advanced from 46,000 cwt. to 80,000 cwt. but those to Germany, Greece and Italy declined from 98,000 cwt., 51,000 cwt. and 48,000 cwt. to 53,000 cwt., 48,000 cwt. and 31,000 cwt., respectively. The United States of America also reduced her taking by 5,000 cwt. to 22,000 cwt.

At the Imperial Agricultural Research Institute, New Delhi, investigations on the wilt disease of sunn-hemp were undertaken during the year. Cross-inoculation tests were started in order to determine the true relationship between the *Fusaria* causing wilt of pigeon-pea and sunn-hemp.

In Madras, ten important varieties were tried for yield of fibre in a 10×6 randomized block arrangement. The Bellary variety proved to be the best. Observations on the general growth, periods of flowering phases, colour, length and strength of fibre indicated that the varieties fell under three groups of duration as early, medium and late. The medium varieties as in last year produced the longest and strongest fibre. The early varieties produced short and soft fibre, while the late varieties produced fibre of inferior quality which was affected by wilt.

In manurial experiments, significant differences in yields in favour of the manured plots were not noted from an economic point of view, i.e. the increased yield did not offset the extra cost of manure applied.

In a seed-rate experiment where three seed-rates of 50 lb., 75 lb., and 100 lb. were tried on the local Dummugudem variety, 75 lb. per acre gave the maximum yield, but the increased yield over the other treatments was not significant. In the lower seed-rates, though the number of plants was correspondingly low, the percentage of useful plants for retting to the total number was high and the total rejected stuff as unfit for retting was less and strength of fibre great.

In a trial to see at what stage of harvest the fibre yield would be the maximum, it was found that yield of fibre at the full bloom stage was the maximum,

but the increased yield was not significant. Maximum quantity of fibre was obtained when the stalks were retted two days after harvest, closely followed by that retted one day after harvest. Retting in general was earlier in still conditions either with clean or muddy water. Retting in muddy water was earlier than in clean water both in still and running conditions. The fibre yield also was greater under muddy water conditions. There was improvement in the quality of fibre in beating and combing, but there was a loss of about 25 per cent of fibre. Bleaching powder was found to be the best of the bleaching agents tried.

In BENGAL, sunn-hemp experiments are still being carried out in collaboration with the Imperial Economic Botanist, to evolve some suitable types of sunn-hemp for the province. A new laboratory method for calculating outturn was also being tested.

In BOMBAY, the early sown sunn crops were comparatively more vigorous than those late sown, but a dark tinge developed on the stems which persisted all along till harvest and finally gave a dark colour to the fibre which very much lowered the cost. Again, these crops became over-ripe before they could be harvested under favourable climatic conditions. This resulted in producing short and weak fibre. The sunn crops sown late by end of August showed signs of wilting and it was ascertained that the fungus disease, anthracnose, was responsible for this trouble.

In the UNITED PROVINCES, the improved type C 12 is now in process of extension. Natural cross-pollination is in this case also a problem. If, however, the entire crop in the eastern districts of the province is replaced by this improved variety, considerable improvement will have been effected in the fibre industry of these parts without danger of deterioration by cross-pollination. About 100 mds. of pure seed of this variety were distributed during the year.

In the CENTRAL PROVINCES, in a varietal experiment with four varieties, namely Jubbulpore, Chhindwara, Cawnpore No. 12 and Pusa, the results indicated that there was no significant difference in the yields of dry stalk and of fibre except that the former three varieties gave higher yields over the Pusa one. A study of the biology indicated that the majority of flowers (62 per cent) opened between 11 a.m. and 12 noon. On rainy days, however, the opening is delayed till 2 to 3 p.m. Studies on dehiscence of anthers indicated that the majority of anthers started dehiscing between 12 noon and 1 p.m. unlike last year when maximum dehiscence occurred between 11 a.m. and 12 noon. The difference is perhaps due to difference in weather conditions at the time of observation. It was also observed that the anthers required on an average one hour to one and half hours for completing dehiscence. To determine the period of receptivity of stigma, about 70 flowers representing different stages were emasculated and hand-pollinated. Results indicated that the percentage of setting varied from 60 to 64 according as the pollination was carried a day previous to the opening of flowers or on the day of opening of the flowers. The setting was about 46 per cent in case of flowers pollinated a day after they had opened. No setting was observed when the flowers were enclosed in paraffin paper bags. The percentage of setting varied from 35 to 50 when the flowers were enclosed in bags and the stigma was rubbed with a camel hair brush. Better results were obtained by artificial pollination or by applying a drop of glucose solution (2½ to 5 per cent) to the stigma before rubbing. Other

treatments, e.g. bagging the flowers and introducing bees or tripping the fully opened flowers inside the bag have not met with much success. It was, however, found that *Crotalaria retusa* formed profuse pods under bagged condition without the stigma being artificially rubbed. With a view to transfer the pod-setting property of *Crotalaria retusa* to *Crotalaria juncea*, interspecific crosses were made. Experiments were conducted to study the effect of seed-rate, time of sowing and time of harvesting on the yield of sunn-hemp stalks and fibre, effect of temperature of water on the retting of the stalks and effect of retting the stalks in running and standing water on the quality of the fibre. A seed-rate of 60 to 100 lb. per acre gave better yield of stalks than those obtained from a lower seed-rate, i.e. 40 lb. per acre. The earliest sown crop gave the maximum out-turn per acre. In the case of the earliest sown crop variations in the seed-rate did not produce any significant differences in the yields of stalks. The effect of different seed-rates on the yield of fibre was not significant. In regard to the effect of sowing dates, the earliest sown crop gave the highest yield of fibre. Highest yields of fibre were obtained when the crop was harvested at the flowering stage. Harvesting the crop at the dead-ripe stage gave the highest yield of dry stalk. The fibre obtained by retting the stalks in running water was fairly clean and free from gummy material and better in colour than that obtained by retting the stalks in standing water. Retting for a period of seven to eight days was necessary during December whereas four to five days were enough during March-April. Prolongation of the period of retting affected the yield as well as the strength of the fibre adversely.

In BIHAR, as a result of a preliminary survey in two districts it has been observed that the area under sunn-hemp as a fibre crop is very small and the crop is grown for home consumption only. Two systems were generally found to be in practice for the retting and extraction of fibres, (i) the dry process, where the crop after harvest is stacked, dried and retted for a varying period of time at the leisure of the cultivators, and (ii) the wet process, in which the crop is retted for three days immediately after the harvest, the idea underlying these processes being that better quality of fibre was obtained by the second process and better yield by the first. These problems are being investigated under Sabour conditions. Under natural conditions, the flowers of sunn-hemp do not set seeds by self-pollination with the result that if the cross-pollinating agencies are for some reason excluded, no seeds are formed. In order to get over this difficulty, a new technique has been devised whereby the bees, the natural cross-pollinators, are employed to affect pollination within the selfing bags. In case the pollinating bees become scarce due to changes in the weather, mechanical pollination with sterilized fingers has been successfully practised. Sixty-seven cultures were studied in lines during the year, and these did not exhibit marked morphological differences. The early varieties yield better quality fibre while the late varieties give the highest yield. Work is continued to evolve desirable strains which will combine high yield and good quality.

Flax

In BENGAL, the Fibre Expert is continuing his experiments with the aid of a small grant from the Imperial Council of Agricultural Research as well as some funds allotted from the departmental demonstration grant. This enabled

him to grow flax in about 30 acres of land in different parts of the province. Unfortunately, owing to unprecedented rain during the monsoon period, *rabi* sowing was very late in most parts. The result was that there were heavy attacks by insects, such as cut-worm, with the result that more than half the crop was lost. During the year the area under cultivators' holdings was considerably increased. Experiments were also conducted on different types of lands, i.e. both inundated and uninundated by floods—the selection of the piece of land being made in such a way that the superiority or otherwise of flax as a winter crop could be judged. Trials with Liral Monarch and JWS varieties were continued and it was found that the former had a tendency to lodge when cultivated on clayey soil, more particularly when the soil was wet and when there were high winds. It therefore seemed to suit lighter areas. Trials were also carried out with Cawnpore varieties. Breaking and scutching machines were supplied to private persons, and extraction was done under the supervision of an expert labourer. The breaking rollers were found to work slow and it added increase in cost. It is proposed to instal a power breaker and to conduct a trial of machine extraction *versus* hand extraction during the coming year. As recommended by the Imperial Council of Agricultural Research, arrangements are being made to establish a central rettery.

During the year retting was done at different places, and from the analysis of water at these places and the fibre produced, it would appear that the presence of organic matter in water had a tendency to produce better fibre. Attempts were also made to extract fibre from flax straw with soap solution. The resulting fibre was found to be too fluffy, sticky and weak.

Experiments on the storing of the straw were also undertaken. It was stored like paddy straw and was found to keep well for one year.

For the supply of seed the department still depends on Karnal in the Punjab ; but a determined effort is being made to see whether good seed could not be produced in the Kalimpong sub-division of Darjeeling. In order to find out the most suitable time for growing this crop for seed purposes, sowings are being made at monthly intervals right throughout the year, careful observations being kept particularly with regard to insect attack.

Rhea

Hitherto in Bengal, planting has been done by using root cuttings, but the new variety now being grown by the Department of Agriculture seeds quite freely, so that multiplication can be done from seed. The crop has been successfully grown in Dacca as well as in Rangpur, but the difficulties with regard to extraction and degumming have not yet been overcome.

In Assam about 80 plants were planted from root cuttings which grew successfully. The growth of plants was noted and it is expected that four cuttings may be obtained within a year. Rhea has certainly a great possibility in Assam provided the problem of degumming and extracting the fibre can be solved properly.

Hemp (*Hibiscus sabdariffa* var. *altissima*)

In Bengal this is being tried out to replace Mesta in the Madaripur subdivision of the Faridpur district. The difficulty, however, lies in the fact that

its seed does not mature in time for sowing in the *bhil* tract, which takes place early in February. Efforts are being made to tackle this problem, and, with this end in view, several new types are being tried.

In ASSAM the cultivation of hemp during the year was very successful. The average height of the crop was 12 ft. 6 in., and it gave a heavy yield. The fibre is softer and whiter than jute. The cultivation of this crop appears a profitable proposition for Assam. The crop might be profitably extended in areas of moderate rainfall.

Mestapat (*Hibiscus cannabinus*)

This plant grew successfully in Assam under Jorhat conditions. The average height of the crop was 11 ft. It took about four months to mature. Fibre extracted at the pod-forming stage was bright, glossy and less brittle. It is considered that the cultivation of this crop might profitably be extended in areas where conditions are not suitable for jute growing.

Sisal hemp

In BENGAL, sisal hemp has shown a special capacity to grow in sandy wastes and it is therefore proposed to grow it in parts of Midnapore on a large scale. In addition to obtaining a valuable cordage fibre, the refuse may he utilized as humus to renovate tbe soil.

In ASSAM a large number of sisal suckers were obtained from the Assistant Fibre Expert to the Government of Bengal and grew successfully.

7. Oil-seeds

Area and yield of principal oil-seeds

The estimated area and yield of the most important oil-seeds in 1938-39 as compared with 1937-38 for the whole of India, including Indian states, are given below :

Crop	Area (Thousand acres)		Yield (Thousand tons)	
	1937-38	1938-39	1937-38	1938-39
Groundnut	8,898	8,439	3,501	3,196
Rape and mustard	5,461	5,508	1,021	926
Sesamum	4,450	4,331	465	396
Linseed	3,890	3,894	461	445
Castor	1,148	1,199	104	111
TOTAL	23,847	23,371	5,552	5,074

It will be noticed that as compared to 1937-38 the total acreage under principal oil-seed crops during 1938-39 decreased by 2 per cent. This fall in the area of various oil-seeds has been reflected in a decrease in the aggregate production which was 5,552,000 tons last year as against 5,074,000 tons during the year under review.

With regard to the relative importance of these oil-seeds in different provinces and states, from the standpoint of acreage under them, it may be noted that groundnut is grown chiefly in Madras where it occnpies about 50 per cent of the total area under this crop in India. Other important groundnut-growing tracts are Bombay Province and Hyderabad State. Rape and mustard are the important oil-seed crops of northern India, being almost equally important in the United Provinces, the Punjab and Bengal. Sesamum is grown chiefly in Madras, the Central Provinces, the United Provinces and Hyderabad State. Linseed is mainly a crop of the Central Provinces, but it is also grown to a considerable extent in Bihar, the United Provinces and Hyderabad State. Castor is grown almost exclusively in southern India, more than half of the total area under this crop in India heing in the Hyderabad State.

Export of oil-seeds

The estimated quantities and values of various oil-seeds exported from India during the year as compared with those of the preceding year are shown below :

Name of oil-seed	Export in tons		Value in Rupees	
	1937-38	1938-39	1937-38	1938-39
Linseed	227,000	318,000	35,680,000	44,045,000
Rape seed	32,000	12,000	4,643,000	1,582,000
Sesamum	10,000	8,000	1,918,000	1,481,000
Castor	42,000	8,000	6,409,000	1,006,000
Groundnut	619,000	835,000	89,330,000	99,272,000
TOTAL	930,000	1,181,000	137,980,000	147,386,000

It is apparent that while the exports of groundnuts and linseed increased by 35 per cent and 40 per cent, respectively, in 1938-39 as compared to 1937-38, there has been a considerable decline in the exports of rapeseed, sesamum and castor. On the whole, however, the total exports of oil-seeds have shown an increase of 26 per cent in quantity and 6 per cent in value over the last year. The larger export of Indian linseed during 1938-39 was due to shorter supplies of this oil-seed from Argentine which considerably helped the off-take of linseed from India. The largest quantities of linseed were shipped to United Kingdom, where Indian linseed enjoys a preference over Argentine linseed. Among Continental countries, Germany and France increased their takings from 7,000 and 6,000 tons to 10,000 and 9,000 tons, respectively.

Research on oil-seed crops

Chiefly as a result of finances provided by the Imperial Council of Agricultural Research, investigations on oil-seed crops are now being conducted on a larger scale than before. The Council has sanctioned several schemes for research on all the important oil-seeds of India in different provinces and states. These schemes are :

(i) Groundnut research in Madras.
(ii) Linseed testing in Bengal.
(iii) Improving linseed, safflower, sesamum and niger crops in the Central Provinces.
(iv) Improving *Brassica* oil-seeds in the Punjab.
(v) Castor in Hyderabad State.
(vi) The investigation of coconut diseases in Travancore and Cochin.

A brief account of the work done on various oil-seed crops in different parts of India and the results achieved during the year under report are given below :

Rape and mustard group

Breeding of improved varieties. The problem of devising suitable methods of breeding for the improvement of self-sterile forms of oleiferous *Brassicae* has been studied intensively in the PUNJAB. Besides mass selection, which has already resulted in the evolution of high-yielding, uniform strains of *toria* (*Brassica napus* L. Var. *Dichotoma*, Prain), *sarson* (*Brassica campestris* L. Var. *sarson*, Prain) and *taramira* (*Eruca sativa*) which strains are now in great demand in the province, a new method of crossing selected plants and their selected progenies by harnessing domestic bees (*Apis indica*) under insect-proof cages with a view to evolving improved strains is proving very successful. Experiments on utilizing hive-bred bees for obtaining increased yields of these crops under field conditions, where the number of insect visitors is ordinarily below the requirements of the crops for purposes of pollination have also shown great potentialities of success.

Pure-line selection work carried out in the Punjab and the UNITED PROVINCES for the improvement of self-fertile forms of oleiferous *Brassicae* has led to the isolation of several high-yielding, disease-resistant varieties of *rai* and *sarson* possessing greater quantity of oil in their seeds. In the Punjab, *rai* L 18 which is suited for sowing at the same time as *sarson*, and *rai* L 16 which is suited for early sowing along with *toria*, have proved to be the best under the conditions for which they are suited. In the United Provinces, *rai* types 11, 3 and 2, and *sarson* types 30, 32 and 11 have proved to be definitely superior to the local unselected strains.

As a result of hybridization between self-sterile and self-fertile forms of *Brassicæ*, several new self-fertile strains of *toria* and *sarson*, which are capable of setting seed well even in cloudy weather when pollination is ordinarily hindered owing to insects not visiting flowers, have been synthesized in the Punjab. These new strains are being tested for yield, etc. against the common forms of *toria* and *sarson* and a few of them show a great promise of success.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, a few spontaneously occurring genic mutations have been discovered, some of which

are considered to be of special importance from the breeding point of view. One such mutation occurring in *toria*, though self-sterile, does not open its petals; the other is an apetalous mutation of *sarson* and is self-fertile. If these mutant characters could be bred into self-fertile improved strains, they would help considerably in keeping down natural crossing by insects and thus ensure the purity of these strains.

Manurial experiments. The problem of finding out the effect of different doses and times of application of various manures on the growth of plants, weight of seeds, yield and oil-content of *toria*, has been under investigation in the Punjab. In the experiments conducted for this purpose, there was no noticeable effect of any of the manures on the height of plants or seed weight. Forty pounds of nitrogen applied in the form of ammonium sulphate, half at sowing time and half at flowering, produced the highest and statistically significant increase in yield. With an increase in yield, the oil-content of seeds was depressed, thus showing that quantity and quality do not go together.

Bio-chemical studies. Investigations carried out in the Punjab on the rate of formation and translocation of oil in the developing ovules of *toria* and brown-seeded *sarson* have yielded interesting results. It has been shown that the most rapid formation of oil begins when the ovules are about 20 days old, and reaches its maximum in ovules of 40 days age. The results also show that the rate of oil-formation is not affected by manuring or by different irrigation treatments.

Vernalization. Valuable work has been undertaken in the United Provinces on vernalization of *rai* seed. By giving a certain treatment to the seed before sowing, its germination was increased, mortality of plants reduced, flowering speeded up and the yield enhanced.

Classification of Brassicæ. To straighten the tangle that exists in the taxonomic nomenclature of various *Brassica* species, the problem is being tackled from different angles so as to base their classification on well-defined genetic groups. In the Punjab, efforts are being made to determine the genetic variability both between and within different species, and to find out the crossability and natural affinities of the various so-called species. At the Imperial Agricultural Research Institute, New Delhi, such studies are being supplemented by cytological investigations of the species concerned, with a view to finding out their phylogenetic relationships.

Groundnut

Selection and breeding of improved varieties. In all the provinces where groundnut is cultivated, the work of improvement on this crop has centred round the evolution, either by selection or hybridization or both, of such varieties as are high yielding, have a high oil-content and better shelling percentage.

In MADRAS, selection AH 334 has given a significant increase of 13·3 per cent in yield over variety AH 25 which has so far been the premier variety of that province. This new strain seems particularly suited to tracts with deficient rainfall. Further breeding work for evolving a type with bunch habit of growth and dormant seeds is in progress, as this particular combination of qualities is in great demand in certain tracts of the province.

In the PUNJAB, the popularity of groundnut is increasing in certain districts where soil and other conditions suit its cultivation. Variety D-3, which in addition to high yield has thin husks, well-filled pods and high oil-content, is finding favour both with cultivators and traders.

In the United Provinces, improved types Nos. 18, 23 and 24 have been evolved, the cultivation of which is now being recommended in rotation with wheat under irrigated conditions. In ASSAM, variety Satara, which has been found to be superior to Spanish, has already established itself in some districts owing to its hardy nature and high yield. In MYSORE, out of the 16 spreading varieties tested against Sogatur as check, Mauritius, Barbados, Nigeria and Virginia have done better. In BOMBAY, variety No. 334 appears to be superior to all the varieties tried.

Effect of storage of groundnut on its quality. An investigation into the rate of development of free fatty acids in four commercial grades of groundnut as a result of storage under normal godown conditions was taken up in Madras at the instance of the Marketing Adviser to the Government of India. The results of this enquiry show that the development of free fatty acids is the least, in 'whole' kernel followed by 'splits' and 'immatures', while the 'nooks' and the 'damaged' kernels deteriorate rapidly. These studies when completed are expected to open up possibilities of improving the quality of Indian groundnut, which at present compares unfavourably with that from other exporting countries.

Effect of climate and soil on groundnuts. With a view to studying the effect of different climates and soils on the yield and other qualitative characters of groundnut, the Department of Agriculture, Madras, arranged trials with four pure strains at 27 agricultural research stations in various provinces and states. In 17 places the trials proved significant, and the results show that the shelling percentage, weight of kernels, oil-content of seeds and yield are profoundly affected by variation in the soil and climate.

Agronomic experiments. Manurial trials carried out in Madras show that the application of cattle manure at 3 tons per acre to supply 50 lb. nitrogen increases the yield, though not significantly. Potassium sulphate at 1 cwt. per acre gave a significant increase in yield. Nitrogen as ammonium sulphate at ½ cwt. per acre influenced the yield only in the absence of basal dressing of cattle manure. Qualitative tests conducted on the produce obtained from various plots, manured differently, did not reveal any effect due to the treatments.

The economics of growing groundnuts mixed with other crops as practised by some ryots, have been worked out in Madras. Of the various crops mixed with groundnuts, *cholam* is seen to depress the yield most, while *cumbu* is seen to be the least harmful. However, from the point of view of profit, groundnut-*cholam* mixture gave the highest return, while groundnut-*cumbu* mixture was the least profitable. Such experiments are also in progress in the United Provinces.

Linseed

Breeding. A rigorous policy of pure-line selection and hybridization followed in different provinces has resulted in the evolution of several improved

strains suited for cultivation in each province. In the PUNJAB, types 5 and 23, which are bold-seeded types, still hold the premier position in the plains. Cross-breeding work is in progress in this province with a view to evolving high-yielding, yellow-seeded varieties possessing better quality of oil for general cultivation, and bold-seeded types with prostrate habit of growth suited for cultivation in hilly tracts. In the UNITED PROVINCES, three superior types (Nos. 1193, 1150 and 1206) as regards yield, oil-content and immunity from rust have reached the multiplication stage. In ASSAM, Pusa type 121 has given the highest yield. In BENGAL, a large number of pure lines have been evolved and tests are under way for selecting the best. At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, a large number of single plants with a high degree of rust-resistance have been selected from F_5 cultures of crosses between susceptible indigenous and resistant exotic varieties. Similar selection work is also proceeding at the BOTANICAL SUB-STATION, PUSA. In the CENTRAL PROVINCES the agricultural, botanical and economic characteristics of a large number of exotic and indigenous selections were studied.

Fibre production. Experiments carried out at Nagpur for finding out the possibilities of obtaining fibre as a by-product from the linseed stalks which ordinarily are not used for any useful purpose have met with great success. A dry scutching machine has been developed which permits the fibre being extracted without any retting process. The fibre thus obtained can be spun into yarn after cottonization, either by itself or mixed with varying proportions of cotton, and woven into quite an attractive fabric. The cost of preparing the fibre for commercial use varied from Rs. 50 to Rs. 80 per ton. In the United Provinces also, some tall types have been isolated for fibre production.

Sesamum

In MADRAS, a new mass-selection SI 885 has been found to be superior to SI 89 which is already under distribution to ryots. Selection 38-12-14-1, isolated from a cross, has also given a significant increase of 11·8 per cent over local. Further attempts are being made to improve the crop by hybridization.

In the CENTRAL PROVINCES, the problem of sterility due to phyllody is being investigated in detail. Selection work has been effective in reducing sterility arising from this cause from 0·97 per cent in 1937 to 0·37 per cent in 1938.

In the UNITED PROVINCES, an exhaustive collection of indigenous and imported strains were tried in progeny rows. White seeded types 1, 6 and 8 indicate superiority over others.

In the PUNJAB, pure-line selection work has led to the isolation of a large number of unit-species, from amongst which type No. 5, which combines white colour of seed with high yield, has so far proved to be the best. Synthesis of still better types by cross-breeding is also being attempted.

Coconuts

The work on coconuts is confined only to MADRAS Province, where they are extensively cultivated for their oil and copra. The breeding work being carried

out on this crop aims at the production of such trees as are dwarf and quick-flowering, bear a high percentage of female flowers, and produce more nuts per tree. This is being achieved by hybridizing the common tall variety that flowers in eight years after planting with a dwarf variety that flowers only in 3-3½ years. In the meantime, the possibilities of increasing the yield of trees by green manuring or by application of mixtures of ash and ammonium sulphate in varying proportions are being explored. By burying coconut husks and leaves in trenches in between the trees, the trees in the treated plots have been seen to be healthier and to retain the leaves in the crown a little longer than those in untreated plots. To overcome the drying up of seed nuts during the interval between the harvesting of such nuts and putting them into the nursery for germination, preserving the nuts in a heap of sand has proved very efficacious. In this way the nuts have been stored for nearly nine months without impairing their germination capacity. Experiments are also being carried out to find out the quality and quantity of both coir and copra from nuts of different maturity. Copra studies indicate that the 9 and 10 months group gives poor quantity and lesser quantity of copra as compared with the 11 and 12 months group. It is also found that the oil-content of the 9 and 10 months old nuts is about 1 to 2 per cent more than that of the older group, which increase, however, is set off against the higher copra yield of the 11 and 12 months old nuts. Various electroculture treatments have so far produced no appreciable effect on coconuts.

Castor

The breeding work at Himayatsagar (HYDERABAD) aims at the production of uniform, high-yielding strains suitable for cultivation in different parts of India. By continuous selfing and by the process of elimination of inferior plants, a few fairly homogenous strains have been built up which are now being tested for yield against the mixed local sorts. Among all such cultures, W 115 is so far leading in yield.

In the PUNJAB, efforts are being made to isolate economic types of short-duration which mature their seeds before the onset of winter frosts that have so far proved to be a serious obstacle in the way of introducing castor cultivation in this province. Some annual varieties imported from Palestine appear to be promising in this respect.

In MADRAS, selection work is proceeding for isolating suitable horticultural and economic varieties. In the CENTRAL PROVINCES, cross-breeding between types Nos. 16 and 31, the former with high oil-content and the latter a better yielder, is progressing to synthesize a new type combining the qualities of both these parents. In MYSORE, selections H 1 and H 6 have given the highest yields. In BOMBAY, type S 20 has proved to be superior to local strains and is now ready for distribution to farmers.

Niger

The work on niger is confined to the CENTRAL PROVINCES, where this crop is of some importance. The niger crop being widely cross-pollinated in nature, efforts are being made to produce such varieties as are self-fertilized and can thus be kept pure easily.

Safflower

In the CENTRAL PROVINCES, special attention is being paid to evolve economic spineless varieties, as the cultivators do not like thorny varieties on account of the great inconvenience experienced in their harvesting and threshing. The botanical study of a big collection of varieties in that province has led to the establishment of certain important correlations which are likely to be of special usefulness in the future improvement work on this crop. As for instance, it has been seen that varieties with whitish florets possess the boldest seeds and that seed setting per capitulum is higher in thorny varieties than in spineless forms.

In the UNITED PROVINCES, out of 63 types under trial, type 56 has been found to be specially suited for seed production and type 39 for forage purposes. At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, some crosses between the cultivated and wild species of safflower are under study.

Cashewnuts

The cultivation of cashewnut trees is proving successful at Nileshwar III (MADRAS). Manuring of trees with cattle manure at 20 lb., ammonium sulphate at 2 lb., bonemeal at 1 lb. and potassium sulphate at ½ lb. per tree has improved their yield considerably. Seeds from healthy and high-yielding trees were selected for distribution outside West Coast districts.

Tung oil trees

These have been recently introduced in COCHIN with great prospects of success.

Introduction of improved varieties of oil-seeds

The Royal Commission on Agriculture in India, in their report issued in April 1928, remarked that although some work had been done on oil-seeds, no striking progress worth recording had been made. They also expressed the opinion that departments of agriculture should devote an increasing share of time and attention to the production of improved strains of oil-seeds. It is gratifying to note that in recent years most of the provincial departments aided by the Imperial Council of Agriclutural Research have taken up extensive and intensive systematic research on more important oil-seed crops of India.

As a result of the investigations so far carried out, several improved strains of various oil-seeds such as rape and mustard, linseed, groundnut, sesamum and castor have now become available and the best of these are being introduced successfully in different parts of British India and Indian states by the departments concerned. It is estimated that the improved varieties of rape and mustard now occupy an area of not less than 200,000 acres in the northern provinces of India which is about 4 per cent of the total acreage under these crops in these provinces. This is a very encouraging beginning. As time goes on, more progress in this direction is sure to be made. Similarly, the improved strains of groundnut, linseed, sesamum and castor are also finding favour with farmers in the areas concerned and suitable arrangements are being made for

the multiplication of seed of improved varieties at the various departmental and other farms in order to meet the increasing demand. There is, however, a vast field for further work in this direction.

8. Tea

The International Agreement for the control of tea for export continued.

The quota for India for the year was fixed at 92½ per cent of the standard export and amounted to 354,499,697 lb.

The consumption of tea in India continues to increase and is in the neighbourhood of 96 million lb. per annum. The amount of money spent during the year on propaganda in India by the Tea Market Expansion Board was Rs. 20 lakhs.

The tea scientific stations in India have had their personnel strengthened by the appointment of Mr T. D. Manning, B.Sc. as Tea Scientific Officer to the United Planters' Association of Southern India and by the addition of Messrs F. S. Mitchell, E. J. Winter and Dr E. K. Woodford as Advisory Officers to the Scientific Department of the Indian Tea Association. These three officers are to be stationed respectively in the Dooars, the Surma Valley and the Darjeeling districts. It has long been felt that the limited staff at the Tocklai Experimental Station did not permit of sufficiently close contact being maintained between scientific investigation and commercial practice and these officers are to strengthen the liaison.

The fertility of a tea bush depends upon the source of the pollen and varies greatly with pollen from different sources. A random collection of nine bushes seems to be necessary to give a fair chance (19 : 1) of an average seed crop. The possibilities arising from a knowledge of the fertility of the material is well illustrated by the case in which selection of the source of pollen resulted in a 25 per cent set of seed on a particular seed-bearer compared with a probable average of 14 per cent. The mixed seed obtained by the free pollination of a collection of tea seed trees is known as a '*jat*'. Since cross fertilization is usual, there is much difference between the individual bushes of the same *jat* in yield and quality of the finished tea. So far the data show no significant correlation between crop and quality, that is to say, it is possible to have a high yield associated with high quality. This is of interest because it has been shown that increasing the yield of a bush by manuring does lower quality. The data also indicate that there is no reason to doubt that there is as high a percentage of good quality bushes amongst the easy rooting strains as amongst the total population.

Individual bushes show marked differences in the readiness with which cuttings form roots. These differences vary with the type of cuttings. Experiments in North-east India indicate that the use of growth-promoting substances such as indole acetic acid may be of some assistance, whereas workers in Ceylon have come to the conclusion that sufficiently satisfactory results are obtained in peat moss to obviate the need of preliminary treatment with chemicals.

Much data has been accumulated to show that the effect of pruning, plucking, cultivation, manuring and manufacture all affect the quality and characters of the finished tea, but that the most important factor is the bush itself. This

serves to demonstrate the need for much more work being done in the direction of plant selection.

A study of the tea plant has shown that two growth forms are recognizable with an innumerable number of intermediate crosses. It has been found that certain characteristics are associated with a general tendency towards a certain position in the taxonomic series and that some characteristics which become evident in the manufactured tea are related to the position the plant occupies in the series.

A disease Phlœm Necrosis is doing considerable damage to tea plants in Ceylon. Its cause still remains obscure. It is suggested that it is a virus disease and recent work has shown that the disease can be transmitted by grafting.

Much damage is done to young tea plants by eelworm *Heterodera marioni*, but in Ceylon it is reported that another eelworm *Anquillilina Prabensis* is causing severe damage on mature tea on three or four tea estates. This is the first recorded instance of this pest doing damage to tea although it is known as a coffee pest.

The long-tailed parasite (*Macrocentrus homonæ*) has been liberated in certain localities in Ceylon and appears to be providing an effective check on the development of the tea totrix (*Hemona menciana*).

9. Coffee

Coffee, as a plantation crop, is chiefly grown on the hills of South India ; on the Bababudan, Koppa, Mudigere, Belur and Saklaspur ranges in the Mysore State, on the Biligirirangan range on the border of the Mysore State and Coimbatore district, in Coorg, on the Wynaad, Nilgiri, Anamalai, Shevaroy and Palni hills in the Madras province, on the Nelliampathy hills lying partly in the Madras province and partly in the Cochin State and on the high ranges of Travancore. Besides these, there are small areas under coffee on the Khasi and Jayanti hills in Assam, on the Chikalda and Kukru hills in the Central Provinces, in the Ranchi district of Bihar, in Orissa and in the Vizagapatam district of the Madras province. A considerable area has also been planted to coffee in small patches, and, on domestic holdings mixed with other plants, in and around the main coffee-growing areas.

Official statistics of area and yield of coffee in India are available only for plantations of five acres or more in extent. The number of such plantations in South India during 1938-39 was 6,860, covering a total area of 346,265 acres. The area actually planted to coffee on these plantations was, however, only 184,975 acres. Of the total area, Mysore accounted for 52 per cent, Madras 24 per cent, Coorg 22 per cent and Travancore and Cochin together 2 per cent.

The season under review was very favourable for the coffee crop. According to the official statistics referred to above, about 18,000 tons of coffee were produced in the year under review as against 15,000 tons in the preceding year. The crop handled by the major curing yards was proportionately more. As against 8,223 tons in the preceding year, these yards received in the year of report no less than 14,000 tons of coffee for curing.

As a result, exports, too, were high. As against 6,757 tons exported during the fiscal year 1937-38, as much as 9,240 tons were exported in 1938-39. The

principal customers of Indian coffee were, in the order of their importance the United Kingdom, France, Norway, Belgium and Iraq. Exports to the United Kingdom were 3,689 tons, which were more than the total exports during the two previous years. Indian coffee, having received attractive prices in London in 1938, was rushed to the United Kingdom early in 1939.

Despite the heavy crop, coffee prices ruled steady during the marketing season. According to the weekly circulars issued by the Mangalore Curers' Association, the highest and the lowest weekly average prices for F. A. Q. Plantation Assortment in the Mangalore market were Rs. 33-8 and Rs. 29-8 per cwt. respectively. The highest and lowest prices for Native (Cherry) coffee—Whole Crop Estate Pounded Coffee with 5 per cent triage—were Rs. 143 and Rs. 117-12 respectively per candy of 576 lb.

Three species of coffee, *Coffea arabica*, *Coffea robusta* and *Coffea liberica* are grown in South India. Of these, *liberica* is of no economic importance, as the cup quality of its beans is far inferior to that of *arabica*, and the area planted to it is negligible. The *robusta* variety, on the other hand, while being hardy and disease-resistant, is not far inferior to ordinary *arabica* in its cup quality. Consequently this variety, though introduced into India only some 30 years ago, has since spread. It now occupies about a tenth of the total area under coffee in South India.

Coffea arabica is by far the most important of the three varieties of coffee grown in South India. On its cup quality, India has earned a reputation in the world markets as a producer of one of the best coffees of the world. *Coffea arabica* is unfortunately a delicate plant requiring favourable soil and climatic conditions conducive to its growth and much care and attention on the part of the grower. The successful cultivation of this variety, therefore, presents a number of problems to the grower, some of which have already been tackled by scientists while some others are now under investigation.

Scientific work on coffee has been undertaken, since 1925, on the Coffee Experiment Station, Balehonnur, in the Kadur district of the Mysore State. This station is maintained by the Agricultural Department of the Mysore State. Efforts are made on the station by the expert officers of the Department and the Coffee Scientific Officer of the United Planters' Association of Southern India to solve some of the more serious of the problems confronting the coffee grower. While the latter is mainly concerned with measures for the prevention and control of the fungus diseases of coffee of which the leaf disease has been the worst enemy of *Coffea arabica*, the former devote their attention to the various other problems of the grower of coffee.

Hemileia vastatrix, the organism causing the leaf disease, has been intensively studied on the station for the past few years, with a view to developing types of *Coffea arabica* resistant to the fungus. This at first appeared to be a promising line of work. For several types of *Coffea arabica* were found resistant to the first two strains (Strains I and II) of the fungus isolated on the station. Later, however, a new strain (Strain III) of the fungus appeared. This strain, though less common than its predecessors, proved to be more infectious. The work of the year under report brought to light yet another strain (Strain IV) of the fungus to which not one of the types of *Coffea arabica* so far tested has proved resistant. Thus the prospect of evolving a type of *Coffea arabica*

completely resistant to all the known strains of *Hemileia vastatrix* has further receded.

Investigations on the use of new spray material and methods were continued during the year. Under the first category, a copper oxide (Perenox) spray was tried out in the hot weather of 1939. Under the second, three different sizes of nozzles were tried on the sprayer. This experiment showed that a larger volume of spray material spread in a given time was more efficacious in checking the incidence of the leaf disease than the longer time taken to spread a given volume of spray material. Another set of experiments under way on the station aims at finding out whether a pre-monsoon spray in May or a pre-monsoon spray in May followed by a post-monsoon spray in September gives a better yield. The observations made during the year showed the value of a second spray in the previous September.

The work of selecting individual plants on the basis of their high yield was also continued during the year. A coffee plant that annually yields 5 lb. or more of ripe cherry, on an average, over a number of years, is arbitrarily taken to be a high yielder for the purpose of propagation. Several mother-plants satisfying this condition have been selected as a result of past work. They and their progeny are still under observation. Five of them, being very promising, have also been selected for further intensive study. It is significant that, during the year, the station was able to distribute for trial, on estates, the seed of a few promising plants of a family raised from the selfed seed of one of the mother-plants referred to. For a number of plants of this family and their progeny reach the standard of high yield. Interesting, too, to geneticists is the observation made on the station that the F_1 generation of a cross between *arabica* and *robusta* produced non-viable pollen. The plants produced heavy blossoms but the set of fruit was negligible and even the few fruits harvested mostly contained nndeveloped beans.

The vegetative propagation of coffee is another of the problems tackled on the station. It was encouraging that some of the plants—*arabica* scions grafted on, in the past, to stocks of Netraconda hybrid and *robusta*—flowered during the year under review. Satisfied with such good results, more grafts were made, during the year, with very few failures. Equally successful was the method, tried on the previous year and continued during the year of report, of grafting *arabica* branches on to the top branches of *robusta* plants. Whether this method is economic and practicable on an estate scale remains to be seen. Experiments on the propagation of coffee by the rooting of stem cuttings were also continued during the year. The effect of treating such cuttings with Hortomone 'A' and Seradix 'A' was studied. The work of propagating coffee through leaf-bud cuttings was given up owing to the large percentage of failures in this method.

The station also devoted attention to the control of the insect pests of coffee. Various proprietory stem-washes were applied on the stems of coffee and the beetles of the coffee stem-borer allowed to deposit eggs on such stems. The effect of these washes on stems on which eggs had been deposited prior to the application of the wash was also studied during the year of report. In another set of experiments, Hongay-oil resin-soap was found to be as effective on the green bug of coffee as two other insecticides tried. The enforcement of the Mysore Insects and Pests Act, in so far as it is applicable to the coffee

stem-borer, was carried on with the funds provided by the station. Borer-infested plants, 3,282,445 in number were reported to have been uprooted and destroyed by planters in the previous year.

Investigations into the methods of preparation of coffee for the market were also in progress during the year. Another subject studied was the differential effect, on the yield, of light, medium and heavy pruning of coffee plants. Incidentally, in the manufacture of composts, the compost made with a preponderating quantity of coffee pulp was found to be finer in quality, and containing more nitrogen than composts made with other materials.

For some years past, London, the most fastidious market for coffee, and also the market that used to pay high prices for Indian coffee, has been complaining of a deterioration in the quality of Indian coffee, and consequently paying lower prices for it. The Imperial Council of Agricultural Research and the Governments of Madras, Mysore and Coorg agreed, therefore, to subsidize a scheme for investigating ' quality ' in coffee, with particular reference to such factors as the age of the plant, its variety, the manurial treatment given to it, the maturity of the fruit, the method of preparation for the market and soil reaction. The work under the scheme was commenced in the last quarter of the year under review. The scheme is under the supervision of the Mysore Agricultural Department. Also, the roasting and liquoring tests on samples drawn from consignments of Indian coffee received in London were repeated by Mr A. J. Parnell in 1939 and much valuable information on the quality of these coffees was furnished to planters in India. The visit to South India, early in 1939, of Mr J. Wheeler Williams, an experienced coffee connoisseur of London, and his contact with planters and planters' associations considerably helped them in tracing to their sources some of the defects in Indian coffee pointed out by the London trade.

The Indian Coffee Cess Committee steadfastly continued its efforts to increase the sale and consumption of Indian coffee in India and abroad. More propaganda centres were opened in India towards the close of the period under review, and the Indian Coffee Market Expansion Board continued to work in the United Kingdom, bringing the excellence of Indian coffee to the notice of the public.

10. Rubber

Rubber is grown mainly in southern India. The statistics given here are based on data furnished by the rubber planters.

The number of reporting plantations in the year under review was 12,204 covering an area of 207,269 acres as against 11,816 with an area of 204,135 acres in the preceding year. The area of old cultivation abandoned during the year amounted to 838 acres, while the new extensions (including replanting in areas abandoned in previous years) are reported to have been 417 acres. The area actually under rubber in these estates amounted to 125,177 acres, showing a decrease of 421 acres on the area (revised) reported in the previous year, and of this area 112,072 acres were tapped. Of the total area under cultivation, 78 per cent was in Travancore, 11 per cent in Madras, 8 per cent in Cochin, 2 per cent in Coorg and 1 per cent in Mysore.

The total production of raw rubber during the year is reported to be 31,065,759 lb. (*Hevea* 36,036,277 lb. and *Ficus elastica* 29,482 lb.) as against

32,296,507 lb. a year ago. The yields per acre of tapped area was 358 lb. in Cochin, 273 lb. in Coorg, 272 lb. in Travancore, 264 lb. in Madras and 85 lb. in Mysore.

The total stock of dry rubber held on the 31st of December 1938 was estimated at 8,051,166 lb. (*Hevea* 8,049,916 lb. and *Ficus elastica* 1,250 lb.) as against 5,260,293 lb. on the same date of 1937.

The exports of rubber by sea from India to foreign countries during 1938-39 amounted to 20 million lb. as compared with 21·4 million lb. in the preceding year. Of this, the United Kingdom absorbed 37 per cent, the United States of America 20 per cent, Germany 20 per cent, Czechoslovakia 7 per cent and Ceylon 11 per cent. These figures are exclusive of exports from Burma.

11. Fruits

The IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH spent large sums of money during 1938-39 to finance horticultural research at several stations. It is mainly due to this financial help from the Imperial Council of Agricultural Research that such a useful work could be pursued by various provincial departments. Of course, the contribution of the provincial departments as well as Indian states in this direction is not less valuable.

The *Review of the Trade in India* 1938-39 shows that Indian exports of fruits and vegetables have advanced from Rs. 208 lakhs in 1937 to Rs. 227 lakhs in 1938-39. There is considerable improvement in the export trade in cashew kernels which rose from 12,700 tons to 13,500 tons valued at Rs. 129 lakhs, the bulk of produce amounting to 11,000 tons being consigned to the United States of America.

Problems relating to propagation and nursery

It is observed that in MADRAS mango seedlings can be lifted with naked roots and transplanted without much damage. The use of plant hormones at Kodur, however, has not shown encouraging results in promoting rooting in mango seedlings. Mango budding has been tried at Sabour, BIHAR with only 30 per cent success and enarching scion shoot of the current year on 2-3 months-old mango seedling, both having a thickness of a lead pencil, gave the best results. At Chaubattia (UNITED PROVINCES), it is observed that the best time of budding apple is September and it does not make any difference if it is done with or without wood at the seat of the bud. Tongue grafting in apple is successful if the joint is covered with grafting wax instead of grafting clay.

As regards the development of private nurseries for supplying reliable stock plants, very little improvement has been made. Reports do not show any attempt on the part of any organization to encourage private enterprise in developing nurseries. Of course, this is one of the lines of improvement recommended by the Royal Commission on Agriculture. Special effort is needed to improve Indian horticulture. It is observed that this line of work has not been tackled by the IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH or any of the provincial departments of agriculture.

Selection of stock and scion

Selection and classification of root stocks is recommended by the Royal Commission on Agriculture. This work is for the present confined to the citrus

stock at Lyallpur (PUNJAB) and Kodur (MADRAS) and apple stock at Chaubattia (UNITED PROVINCES) and BALUCHISTAN. Selection of other stocks such as mango, *chiku*, etc. have not been taken in hand anywhere.

At Kodur (MADRAS), *jamburi* stock has proved to be the most outstanding in respect of root system and girth. The study of 2½ years' old scion plants on certain root stocks propagated both by seed and cuttings at Lyallpur shows that *kharna khatta* raised from seed or cuttings increases the vigour of the scion. Scion plant on sweet lime propagated by seed, however, lacks vigour, but shows vigour next to *kharna khatta* when propagated by cuttings. The performance records of root-stock varieties raised from seed show that *mokri* produced seedlings of greatest uniformity while *galgal* produced variable seedlings.

At Chaubattia, six apple root-stocks, viz. Crab C., Malling Type XIII, Malling Type II, Merton 779, Merton 793 and Local I were selected, having due regard to vigour, root system, freedom from pests and diseases and ease of propagation. Scion varieties such as Delicious, Jonathan and Rymer known to bring about cross-pollination were budded on these stocks with the result that Rymer proves to be more vigorous than Delicious and Jonathan.

With a view to improving the quality of stocks for fruit plants in Baluchistan, 5,568 root stocks of 29 different types of apple have been imported from East Malling Research Station, England.

At Kodur, a large number of mango seedlings from ten different polyembryonic varieties have been raised for root-stock trials, but in an experiment to ascertain the relation of age of the seedling root-stock to the growth of grafts, no significant difference is noticed. The root-stocks were of the same age but enarched at varying periods at 10½, 13½ and 16½ months.

Nine varieties of apples imported from East Malling have been introduced at Mysore for stock experiment.

The selection and classification of root-stock, as stated above, is confined to only a few experiment stations. Recently the stock work has been extended to several stations at the suggestion of the Agricultural Commissioner with the Government of India. As this work is very important, it is suggested that it should be extended to other important fruit crops in various provinces.

Investigations relating to cultivation, irrigation and manuring

The results of experiments in manuring citrus trees at Lyallpur show that the application of 4 lb. of ammonium sulphate per tree to Malta orange gave an average increase of 54·1 per cent in the yield of fruit. Manurial trials of banana are laid out on an elaborate scale for the third time at Poona. In this experiment the effect of farmyard manure in combination with different artificial manures as top dressings is being studied. The experiment is laid out on Fisher's randomized method, with nine plants instead of six as in the previous report. Manurial experiments on mango and grape vine are also laid out. Bed *versus* furrow methods of irrigation for citrus and grape vine crops are also under trial. At Hesargatta (Mysore) manurial trials on pineapples are laid out.

Introduction of improved varieties of crops

Basrai, Rajapuri, Red Bassein and Mutheli varieties of banana are being tried at BARODA. Several varieties of banana obtained from Dacca, Bombay

and Saharanpur have been introduced at Krishnagar. In MADRAS, a number of varieties of grape vine, pomegranate, guava, fig and loquat are under trial. At Chaubattia (UNITED PROVINCES), ten commercial varieties of apples in respect of early, mid-season and late have been selected for field trial. It is observed from girth measurements that varieties such as Esopus, Spitzenberg and Beauty of Bath are significantly less vigorous as compared with Early Shanburry, which is taken as the standard. A variety trial plot with nine varieties of dessert apples has been laid out at Mysore. Several varieties of fruit plants such as pineapple, fig, papaya, guava, peach, *litchi*, avocado, strawberry and sapodilla are also under trial.

Picking, packing grading, transport containers, etc.

Grading and marketing of grapes and peaches in Baluchistan under 'Agmark' labels have increased receipts by growers by 21 per cent and 64 per cent respectively. The advantage of *stenophylla* grass over paddy grass as a packing material for packing peaches, apricots and apples is being investigated. Grapes are transported better when packed in Stenophylla than when packed in paddy straw. Straw is not regarded as a suitable packing material as it imparts an objectionable odour.

It is observed that the whole question of picking, packing, transport and establishment of regular markets is now principally dealt with hy the marketing establishments in various provinces. They are doing a good deal of work and the benefits of this research are already being realized by the growers. Most of the commercial fruits such as mangoes, oranges and grapes are being graded at several centres and the growers are getting better prices for the graded produce. As regards the market facilities, the Bombay province has already a scheme in hand for the regulation of wholesale markets.

Canning and preservation

Results of investigations on fruit juices in the PUNJAB show that the addition of peel emulsion and orange oil to orange squash has not yielded a superior product. The flavonr of *santra* squash, however, is improved by the addition of citrus peel emulsion or essential oil of Malta. Blending of a variety of citrus juices has been tried with some success. Sulphur dioxide gas is found to be a good preservative for lemon and sour lime juice, but not for Malta orange juice. *Phalsa* juice or syrup preserved with nitrogen has given good results.

In BALUCHISTAN, work on fruit preservation was confined to canning trials on peaches, preparation of juice and syrup from seedless *kishmish* grapes and drying of grapes. Haitha grape yields a good quality of dried product if subjected to hot alkali-solution treatment.

A variety of fruit products have been prepared from *kagdi* lime in the BARODA laboratories.

As regards cold storage investigations in the PUNJAB, trials on the Langra mango show that the use of 5 per cent borax solution reduces the wastage. Pears of A and B stages of maturity stored very well for a period of 5½ and 4½ months respectively at 32°F.

Respiration studies on the mango at Poona show that the fruit respires more at the time when it changes colour. Chilling of ripe fruit does not influence

the rate of respiration. The mango is chilled at 52°F. The fruit just 'turning' shows browning more than the ripe fruit. The banana, which is harvested during summer, does not gèt as good a colour as it does when harvested during the winter. Cold storage trials have been made on apple, *chiku*, custard apple, potato, onion, cauliflower, peas, beans and beetroot.

The question of the application of cold storage results to the trade is yet an unsolved problem. In some quarters it is believed that this research is ahead of the times. It is believed that unless refrigerated transport develops and the market is regulated, the use of cold storage for storing fruits and vegetables may not be found economical.

Periodicity in bearing

Periodicity in bearing is now an important problem which is attracting the attention of various investigators in different provinces. At Sabour, observations on alternate bearing in mango show that the varieties which produce the least number of panicles have marked alternate bearing tendencies as in Langra and Bombai. Baramashi produced a very large number of mixed flowers but setting is very poor. Fazali, which gets only one flush, produces a good deal of mixed panicles, but the fruiting is very poor. The problem of alternate bearing in Fazali, therefore, is less intense. Observations on deblossoming with special reference to alternate bearing are being made.

At Kodur, analysis of performance record of a certain mango plantation shows that an 'on' year is not necessarily followed by an 'off' year and *vice versâ*. Bearing is also not influenced by the performance of the tree in the preceding year. Floral studies in mango at the same place show that the percentage of perfect flowers varies from 16·41 in Neelum to 3·47 in Allampur Baneshan. These percentages, when considered with the performance of the variety, indicate that high percentage of perfect flowers is closely associated with high productivity. Observations on individual panicles show that the terminal portion of the panicles bears the largest proportion of perfect flowers, the basal portion containing the least.

Pests and diseases

In ASSAM, the attack of woolly aphis is controlled by spraying "Black leaf 40" and Bordeaux mixture. In the PUNJAB, cultural and control studies of wilt of citrus seedlings show that the disease can be controlled by the application of 1 per cent of formaldehyde solution to infected soil and by providing better aeration and light irrigation. It is observed at the same place that citrus varieties such as Sylhet Rangpur, *kagdi* lime and Mokri appear to be most susceptible to citrus canker, while *khatta*, grape fruit and *santra* are immune to it. Further studies on Gajanima (a citrus variety) at Kodur confirmed its susceptability to gummosis. At Krishnagar, mango leaves affected by anthracnose disease (*Colletotrichum glœosporioides*) can be controlled by pruning and spraying thrice with Bordeaux mixture (5 : 5 : 50) mixed with linseed oil at intervals fortnightly.

Other research work

In MADRAS, trials on tapping papaya trees for papain show that morning and evening are the best times for tapping. Tapping may be done at an interval

of four to five days. Tapping hastens the ripening of fruit. Studies at Sabour in respect of sex in papaya show that in plant population, 30 to 60 per cent turn out to be males, while a number of plants show sterility. At Krishnagar, pruning of male papaya plants at different heights with a view to determining its influence on the change of sex proves a failure.

In the UNITED PROVINCES, an experiment on electroculture with fruit and vegetable crops has been laid out with a view to adopting a cheap method in horticultural practice. A similar experiment has also been laid out at Chaubattia. Treatments like simple jacketing, jacketing and sparking and electrified irrigation water have been undertaken on old bearing trees and also on young plants. Observations show that the application of electrified water has proved harmful.

Trials in the PUNJAB show that the application of treatments like ringing and root pruning in non-bearing *santra* trees six weeks before the date of flowering has resulted in trebling the yield. At Kodur, ringing at the base of the mango shoot removing ¼th inch wide bark gives 68 per cent shoots and further gives 20 per cent of fruit set, but healiug of wounds is unsatisfactory. Cincturing and etiolation of mango shoots with a view to stimulate root production have proved a failure.

At Chaubattia, the results of thinning of fruits in apple trees indicate that (*a*) there is no difference in the gross weight of fruits in treated and controlled trees, (*b*) fruit size increases with severer thinning and (*c*) thinning induces better colour of fruits. Bark ringing of the trunk of unbearing apple trees induces more abundant flowering than in unringed trees. At the same place an experiment to study the effect of four different systems of pruning has been laid out on young apple trees of Red Astrachan variety.

12. Fodder crops and grasses

The Royal Commission on Agriculture made the following five recommendations for the development of the fodder resources of this country :

1. introduction of improved varieties of fodder crops,
2. improvement of grazing facilities,
3. promotion of the use of silage,
4. encouragement of the cultivation of leguminous fodder crops, and
5. grazing in forest areas and the fodder supply from these areas.

The majority of the provinces and a few of the states have implemented to a greater or less degree some or all of the recommendations. The progress achieved is by no means considerable. In some of the provinces and states, these measures are still in an experimental stage and in others they have reached the stage of demonstration, but in no province can it be said that the recommendations have been fully implemented.

Ensilage. The promotion of the use of silage is the most difficult to popularize. It is only on Government farms and private dairies and cattle breeding farms that the method is regularly practised. There is general apathy among villagers, and it will need time to overcome this.

Leguminous fodder. In some of the provinces attempts are being made to collect all the wild leguminous fodders for selecting the best among them for introduction in pastures.

Fodder crops. Except under irrigated conditions, crops having only fodder value do not find favour with the farmers. The crops raised have to serve two purposes, viz. to provide grain for the people and fodder for the cattle. The agricultural departments of the provinces and states are trying to improve suitable crops to answer both these needs.

Grazing. Facilities for grazing and their control are being better organized by the forest departments. The rights and privileges conferred under old legislation hinder rapid progress. In some provinces revision of forest grazing rules to put an end to the misuse of pastures has been undertaken. But there is considerable opposition to passing these rules since the very persons who would benefit by them are averse to losing their so-called rights and privileges.

Fodder trees. The utility of fodder trees as a source of fodder is receiving greater attention and forest departments are being urged to pay more attention to planting trees which will serve multiple purpose, viz. fodder, fuel, conservation of soil and other minor needs of villagers.

Famine. The severe outbreak of drought in the Hissar district of the Punjab, Kathiawar States, parts of Sind and some districts of Gujarat in Bombay Province in 1939 took a heavy toll of cattle. Fodder became so scarce in these places that it had to be imported and valuable cattle were transported to areas where they could be maintained. In the affected areas, Governments took prompt measures to protect cattle and to prevent profiteering in the sale of fodder to buyers in famine areas. The district of Hissar, in which one of the finest breeds of cattle in India is raised, was the worst affected. In a country like India where there is periodic occurrence of famine it is high time that measures should be taken to provide for such exigencies and that some method of storing fodder in sufficient quantity and their renewal every year should be devised. The famine of Hissar should serve as an eye-opener to store sufficient fodder for use during scarcity to prevent the loss of valuable cattle which are already too few in this country.

IMPERIAL COUNCIL OF AGRICULTURAL RESEARCH. *Central Fodder and Grazing Committee.* The committee held its second meeting in November 1938, and made the following recommendations: (1) bibliographies should be prepared on (*a*) Indian grasses, grasslands and fodder crops, (*b*) erosion and (*c*) experiments on feeding tests be published; (2) the estimate of animal food available from all sources prepared by the Council should be revised to include the average figures for the past five years so as to provide correct estimates; (3) the possibility of using suitable plants as cheap and live fences for grazing areas should be tried wherever possible and the cost of their preparation and management be determined; (4) collection of information from the provinces and states on the best method of storing fodder should be undertaken; (5) collection of results obtained from rotational grazing experiments conducted in India should be made available for publication, and (6) simple and inexpensive methods of *bunding* on grazing areas to prevent surface run off and soil erosion should be encouraged.

The committee approved with certain modifications two schemes relating to management and improvement of grasslands received from Bombay and the United Provinces.

IMPERIAL AGRICULTURAL RESEARCH INSTITUTE. Investigations on important problems such as production of pure berseem seed at cheap rate, water-

requirements of berseem and the yield of alternative fodder crops were continued. In a replicated trial of six *rabi* fodder crops it was observed that berseem gave the highest yield although it received the largest number of irrigations. The point in favour of berseem is that it yields green fodder even during the winter months, which cannot be said of any of the alternative fodder crops tried.

When green berseem fell short, the milk yield of the Sahiwal herd was kept up by feeding ensilage.

Research schemes financed by the Imperial Council of Agricultural Research

Analysis of indigenous fodder in Bihar. Three years' work has been completed under the scheme. The following is a summary of the main features of the years' work: (*a*) berseem has proved to be the best fodder followed by *meth* (*Phaseolus* sp.) and *khesari* (*Lathyrus sativus*). Paddy straw and *jowar* are the poorest fodders. The grasses *dhub* (*Cynodon dactylon*) and Napier occupy intermediate places between leguminous fodder and poor fodder such as maize, *jowar* and straws of rice, wheat and barley. The mineral constituents of fodders tended to decrease with advancing age with the exception of nitrogen extractives which increase. The influence of soil condition on the constituents of fodder was marked. It was observed that season also affects the quality of fodder.

Manufacture of cattle feed from molasses. Since the first trial of feeds prepared with bagasse screenings and molasses showed that they were unpalatable, it was decided to use finer screenings of bagasse. Analysis of bagasse screening of different fineness and the change in their composition is being investigated.

Cattle feeding research in the United Provinces. Two breeds of cattle, viz. Hissar and Murrah were used for the experiments to test the possibilities of replacing the concentrates by berseem by noting the effect on milk yield and growth. The investigations show that the two breeds do not react in the same manner in respect of milk yield, growth and the extent to which berseem could replace concentrates without producing adverse effects. The variations in soil characteristics have shown to have some effects on the composition of berseem.

Work done in provinces and states

Assam. Extensive grazing reserves in which the cattle are under the control of the agricultural department are maintained. Demonstrations were given in the construction of silos and the preparation of ensilage. Some of the fodder grasses have given very high yields which is encouraging. Aquatic grasses are being studied for selecting suitable types. Paragrass, an aquatic type from South Africa, has done so well that it was distributed on large scale.

Bengal. The cultivation of crops purely for fodder for cattle is new to the province and attention is, therefore, being paid to increase the area under Napier grass, *jowar*, maize and *khesari*. During the year floods have caused much damage to Napier grass. Since much of the land available is required

for food and cash crops, land for grazing or pasture is not available in the province. Floods during rains and absence of rain during dry weather are factors against establishment of pastures. Progress in inducing cultivators to prepare ensilage is slow.

BOMBAY. The large-scale experiment on rotational grazing was continued. In a count made of trees growing in a shrub jungle near Poona, it was observed that only 6 per cent of the trees were useful for fodder. Recommendations to plant more fodder trees in arid areas have been made to the Forest Department.

The Provincial Fodder and Grazing Committee constituted during the year met twice and discussed in detail several subjects. Amongst the most important were (1) the establishment of a central grass and fodder crop research station ; (2) survey of grasslands ; (3) forest grazing rules and (4) provisions of drinking water for cattle in grazing areas.

CENTRAL PROVINCES AND BERAR. Experiments on the improvement of grasslands have been framed. Propagatiug material for introducing new types of grasses has been obtained from Ceylon.

COCHIN. Guinea grass is the main fodder crop and it grows satisfactorily. Trials on Napier and Elephant grasses have been taken up.

MYSORE. Sunflower, *jowar*, soyabean, lucerne, Rhodes and Napier grass were grown on Government farms. Efforts are being made to popularize the cultivation of Napier grass which has been found to be an additional source of green fodder available throughout the year.

ORISSA. From the grant of Rs. 800 given by the Cattle Protection Society, seeds of various fodder crops were purchased and distributed free to cultivators all over the province.

PUNJAB. The urgent requirement of the province in regard to fodder crops is not one of evolving new types, foreign or indigenous, but supplying adequate quantity of seeds of the improved types. Large bulk of dry fodder from crops grown for seed is wasted for want of purchasers. Berseem, the most popular fodder, will not produce seeds except in the cooler parts of the province. Consequently there is a very heavy demand for this seed which has to be met from supplies from the North-West Frontier Province. The increased demand for seed is creating a tendency among the seed firms to buy up all supplies and force the price up.

The constitution of a Provincial Fodder and Grazing Committee has given a fillip to improving natural grass and grasslands. The question of survey of grasslands of the province is under consideration.

The Hissar district was affected by a very severe famine and cattle died in large nnmbers. Measures were taken to save valuable cattle.

TRAVANCORE. The cultivator is not in the habit of growing fodder crops. In the past, village common grazing grounds were available but increase in population has resulted in the utilization of these waste lands for growing crops and so the common grazing areas have disappeared. The cultivator is now forced to provide his own grazing ground and grow fodder crops.

Root stocks of Guinea and Napier grass and seeds of fodder variety of *jowar* were distributed on a large scale to cultivators to encourage greater production of fodder. Unless the problem of raising sufficient fodder is solved, livestock improvement cannot be taken up because of the inadequacy of fodder supply.

13. Millets

The work on millets was in progress in practically all the provinces. In MADRAS, types suited to different areas have been evolved and are being distributed to cultivators. In MADRAS and the PUNJAB, the work has been entrusted to special botanists, while in other provinces the work is being done by the staff working primarily on other crops.

Millets are naked grains and are more liable to insect attack and weather damage than any other grains. The majority of them are wind-pollinated and hence give rise to innumerable varieties. Not only is great care required in the original selection work but continuous selection is required to maintain their high yield and purity of type. This further necessitates special agencies for continuously supplying pure nucleus seed.

The fact that millets are primarily consumed by the poor, are grown in areas of poor rainfall, with a comparatively lower standard of agriculture and do not figure much in commerce, adds to the difficulties of producing and spreading improved types of these crops. The crops therefore need more sympathetic and liberal treatment by Governments.

Cholam has been found to produce malt which can be used in the manufacture of biscuits. The manufacture of starch also requires looking into.

The millets are generally grown under *barani* (unirrigated) conditions. The work on the suitablity of different types for these areas is also being conducted at different dry farming stations in Bombay, Madras, the Punjab and Hyderabad.

The three main millets cultivated in India are *Jowar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*).

Jowar (*Andropogon Sorghum*)

The total area under *jowar* in India during 1938-39 was 33·8 million acres. Hyderabad has the largest acreage of 8·4 million acres, followed by Bombay with 7·8 million acres, Madras with 4·9, the Central Provinces and Berar with 4·3, Bombay States with 2·9, and the United Provinces with 2·2 million acres, others had less than a million acre under this crop.

The total estimated production was 6·4 million tons.

In HYDERABAD the work is being done on both *kharif* and *rabi jowars*. In BOMBAY, the work is being done at Niphad and Jalgaon. In MADRAS, strain A S 1543, A S 2095, A S 1575 and in summer *cholam*, A S 809, A S 1575, and A S 2095 yielded better than the local. Hybridization work is also in progress. The crosses between Peria Manjal *cholam* and African Bongonhile and Bombay Silichigan were found resistant to the attack of *Striga*, a root parasite on the *cholam* plant. These crosses have been back-crossed with Peria Manjal *cholam* for combination of *Striga*-resistance and high yield. Improved seed, 14,050 lb., of different varieties was distributed. At Hagari Dry Farming Station, it was observed that sorghum following fallow had double the root system than when these were followed by a previous crop.

The scheme for the study of the chemistry of malting *cholam* terminated in 1938. The conclusions were:

(a) malt can be kept in vacuum tins without deterioration or loss of aroma for at least six months.

(b) Storing as malted grain in vacuum tins tends to enhance the keeping quality.

(c) High humidity was found to lower the keeping quality.

(d) *Cholam* malt, being cheaper, can be utilized for making malt biscuits, malt cakes and malt cream.

(e) Blending of malt meals from two or more chosen cereals may be of use in the preparation of malted food containing very low fat content.

In the UNITED PROVINCES, types 8*b* and 5 tall have proved their superiority and in the PUNJAB J 8 has continued to give better result than the local. In MYSORE, preliminary work on *mungar jola* (*jowar*) is being done. *Striga*-resistant varieties, four from Burma and South Africa and one from the farm were under test but were found to be poor yielders. The Kalapayag variety gave the highest yield of 15 srs. of grain and 188 lb. of straw. The *Striga*-resistant variety will be used for breeding purposes.

In TRAVANCORE, two exotic varieties from Nagpur were tested and gave satisfactory results. In BOMBAY, at Sholapur, growth studies showed that the growth in height of *jowar* also continues during the night.

Bajra (Pennisetum typhoideum)

The area under *bajra* was 17·2 million acres. Out of this area, 12·6 million acres were contributed by different British provinces and 4·6 million acres by Indian states. The areas in order of importance as regards acreage, were Bombay (4·09), Madras (2·7), the Punjab (2·6), the United Provinces (2·05), Bombay states (2·08) and Hyderabad (1·80 million acres). Other provinces had less than a million acre.

The total estimated out-turn was 2·54 million tons.

In BOMBAY, the work is being carried on at Niphad. The advisability of transferring the *bajra* work to a more suitable centre is being considered. The keeping of the purity of *bajra* by growing it in the off-season was also studied, but the setting obtained was poor and no crop was received. It has been observed that the evil effects of inbreeding for a few years are not easily regained by group breeding. Some cultures like 28-15, AK 297-6 and 187 yielded better than the local sorts.

In MADRAS, different varieties have been evolved to suit different parts of the province. P T 2229, P T 499 and P T 700 suit particular parts of the province. Different improved *bajra* varieties, 2,439 lb., were distributed.

In the PUNJAB, type A 1/3 continued to give a good account of itself, provided it was grown under good rainfall or under irrigation. The advisability of transferring work to other places is also under consideration. In the UNITED PROVINCES Types 11 and 16 have been proved to be superior and are being extended.

Ragi (Eleusine coracana)

It is grown over an area of about seven to eight million acres in India. Mysore and Madras are two important growing centres. It is also grown in other parts of the country.

In MYSORE, K 1 *ragi*, an early maturing and high yielding variety, is popular both for *Kar* and *Hain* cultivation. E. S. 11 is a good variety which promises to become popular. In MADRAS, E C 593 has proved to be the best type. At Hagari R42 proved superior to all strains including E C 593. 11,032 lb. of E C 593 and 2,132 lb. of other varieties were distributed.

In the UNITED PROVINCES, Mandua (*ragi*) 161A has given the highest yield. In ASSAM, 15 strains from Coimbatore were tried. E C 593 and E C 1543 set seeds, while others were unsuccessful.

Tenai and Korra (Setaria italica)

In MADRAS at Coimbatore S I 523 proved its superiority. At Hagari K24 gave the highest yield.

14. Other Cereals

Barley

The estimated area and yield of barley in India during 1938-39 were about 6 million acres and 1·9 million tons, respectively, which represented a decrease of 2 and 11 per cent as compared to the corresponding figures of the year preceding. This fall, both in acreage and production, is mainly attributable to lack of rains at sowing time and during the growth period of the crop. The chief barley growing provinces were, as usual, the United Provinces, Bihar and the Punjab which, respectively, contributed about 3·9, 1·3 and 0·6 million acres to the total acreage.

A brief reference was made in the last report to the detailed results obtained by subjecting barleys from the above three important barley-growing provinces to malting and brewing tests in England for three successive years, with financial aid provided by the Imperial Council of Agricultural Research. These tests, by indicating the directions in which improvements are needed to enable the Indian barleys to hold their own against the best malting and brewing barleys of the world, have proved of immense value, as in the light of the results obtained from them a new orientation is being given to the research on barley in these three provinces. A brief outline of such and other work which was in progress on barley in India in 1938-39 is given below :

UNITED PROVINCES. The tests showed that edaphic and climatic factors markedly influence the malting and brewing qualities of a barley type and that type C 251 grown at places like Raya can match in quality the Californian barleys, which are considered to be the best for malting and brewing purposes in England.

In order to accelerate the barley improvement work, which had hitherto been centred at Cawnpore and Raya, research on this crop was extended to three more experimental stations, viz. Nagina, Belatal and Gorakhpur. A five-year scheme at a total estimated cost of Rs. 13,500 was sanctioned by the Imperial Council of Agricultural Research for conducting surveys for picking out still better sorts and for instituting yield trials with local varieties against the standard type C 251 on experimental farms and on cultivator's fields in 40 representative centres in the UNITED PROVINCES, with a view to determining the localities in which barleys develop their malting and brewing qualities to the highest pitch.

In the yield trials carried out during the year at five representative centres with five newly evolved varieties against C 251 as standard, barley type P 21, though highly susceptible to smut, gave the highest yield and types C 84 and C 94 appeared promising.

From among thousands of single-plant selections secured as the result of a survey of the provincial barley crop carried out in 1938, strains numbering 507 were selected on the basis of size and colour of grain and yield. In addition, fresh surveys were made in nine districts and 400 single-plant samples were collected.

PUNJAB. Malting and brewing tests carried out by the Institute of Brewing, London, on Punjab barleys showed that types Nos. 4 and 5 (which are also satisfactory croppers in the respective tracts for which they are recommended) malted easily and satisfactorily, and the malts made from them were distinctly more attractive than the original barleys themselves. Also the beers yielded by these malts were normal. The physical appearance (i.e. colour) of these barleys was, however, not so bright as to commend them to purchasers in England unaccustomed to their use. This does not constitute a handicap, however, against their preferential use by breweries in India itself, who being accustomed to Indian barleys know by experience that the somewhat weathered appearance of these Punjab types is only skin-deep and does in no way detract from their pre-eminent excellence as malting and brewing material. Further, it is hoped that when the intrinsic value of the Punjab types becomes known in England, they would be readily taken up by maltsters and brewers there. Meanwhile the work on the evolution of varieties combining high malting and brewing qualities with a nice appearance of grain is proceeding apace. Of a number of new barley types synthesized in the Punjab by cross-breeding, three, viz. Nos. C 103, C 107 and C 111, gave considerably higher yields for the third year in succession than the present improved types Nos. 4 and 5. Some other crosses also did well, though to a less degree. If these new cross-bred types continue to give such good yield performance for another two or three years, the Punjab Agricultural Department would be in a position to introdnce still better varieties of barley in the province, where this crop annually occupies, on the average, three-quarter million acres and where it is of particularly great economic importance in some south-eastern districts like Hissar and Gurgaon with their very uncertain agricultural conditions.

The malting and brewing tests carried out in England on Punjab types also showed that type 5 grown in Muzaffargarh district (where agronomically it makes a much better fit to the prevailing conditions than type 4) gave in some cases even better results than type 4. This finding is of considerable significance as it reveals a potential source of production of high-quality malting and brewing barley, which can be tapped in case of need. These tests also revealed that heavy soils and adequate supplies of water, by reducing the nitrogen content of the grain, produced a better quality malting barley.

BIHAR. Preliminary yield trials at Pusa with two-rowed and six-rowed, both husked and huskless, barleys were repeated. The deficiency of winter rains affected the yield and none of the types and hybrids tried out-yielded the standard Pusa type 21.

Seedlings of 50 strains tested at Agra (UNITED PROVINCES) for their resistance to a mixture of the six Indian physiologic races (Nos. 15, 21, 24, 40, 42

and 75) of black rust (*Puccinia graminis*) were all found to be susceptible. Three hybrid barleys were found to be attacked with dwarf rust (*Puccinia simplex*). This is perhaps the first time that this species of rust has been reported on barley in the plains of India since previously it was reported as occurring only in the Nilgiris and Palni hills.

Hot-water treatment against smut applied to barley (P 21) was found to be perfectly effective in preventing this disease in the resulting crop. This bears out the results obtained from this method in the PUNJAB. Application of Universal Uspulun too was found quite effective for the same purpose, as in a crop of type 13 raised from seed treated with this disinfectant, only about a dozen smutted plants were found over an area of two acres.

Cereal Rust Research Laboratory, Simla. A new race provisionally designated G was isolated from a collection of yellow rust of barley made in the previous year. Study of wind curves has again shown that, in a crop, infection is first noticed only after a fortnight of the passage over it of winds carrying the load of rust spores.

Maize

The all-India area under maize was estimated to he 6¼ million acres, which was about 1 per cent higher than in the previous year. In spite of this increase in acreage, the production was 1·87 million tons only, which is 11½ per cent less than that of the preceding year. This appears was mainly due to inadequate rains during the growing period of the crop. The chief maize-growing tracts were the United Provinces, Bihar, the Punjab and Hyderabad (Deccan), where this crop occupied an area of about 2·1, 1·5, 1·1 and 0·6 million acres, respectively.

In the UNITED PROVINCES, three types, viz. Nos. 13, 19 and 41, which are reported to yield, on the average, 28 to 30 md. of grain per acre, are being recommended for distribution to farmers on account of their high-yielding capacity.

In the PUNJAB, maize selections Red 1 and White 1, of which the latter is a late-ripener, have been found to be heavy yielders in the tests carried out at departmental farms. Elephant grass barriers between the breeding plots proved effective in checking natural crossing, but at the same time turned out to be uneconomical and a source of great loss of moisture to the main crop in their neighbourhood. As a result of further work in this direction, it has been found that sugarcane is a much more profitable and equally effective substitute for this purpose. Belts of sugarcane, 15 ft. wide, between the maize-breeding plots reduce the amount of crossing between the adjoining cultures to a negligible figure. This finding is likely to be of great use in the multiplication of improved maize seed for distribution purposes.

Three Pusa selections, viz. Nos. 1, 2 and 3, are getting gradually acclimatized at New Delhi, where during the year under report they gave higher yields than last year.

Oats

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, study of the resistance of Pusa oats and some naturalized exotic strains to covered

smut (*Ustilago kolleri*) was continued. Four of the five types found resistant last year remained so this year under conditions of most vigorous infection. Another resistant type was also discovered.

15. Potato

SIMLA. The varieties of cultivated potatoes collected from all over India were studied further with a view to finding out the range of variability of the more important morphological and physiological characters. Some more duplicates were eliminated during the year and final identification of the varieties has been taken up at the Imperial Agricultural Research Institute with the cooperation of Dr R. N. Salaman of Cambridge. Some of the interspecific hybrids imported from America, which have proved to be very good yielders and highly resistant to frost, were used for crossing. A new species, *Solanum-Rybinii*, was added to the collection of South American species.

Photoperiodic studies have revealed that unlike *S. tuberosum* many South American species produce tubers only under a short daily photoperiod of 9-10 hours.

New material has been received from the Empire Potato Expedition to South America. Attempts to transfer the high disease-resistance qualities of the South American potatoes to the best commercial varieties of *S. tuberosum* are being continued and some more intervarietal and interspecific crosses were made. A study of the crossability among various species was started.

Experiments on dormancy and storage were in progress at the Imperial Agricultural Research Institute. Attempts will be made to exploit the short resting period of some South American species such as *S. phureja* and *S. Rybinii* for breeding purposes. Further studies on the keeping qualities of different species seem to indicate that varieties which sprout earlier rot quicker than those with long periods of rest.

DELHI. At the Imperial Agricultural Research Institute, experiments have been conducted to determine the best time for planting potatoes here. In the case of two varieties, Gola and Military, the planting done on the 30 September gave the best results while with Phulwa, this planting as well as the one on the 15 October gave very good results, the latter being slightly better.

MADRAS. At the Nanjnad Agricultural Research Station, breeding work on potatoes was discontinued with the closing down of the potato scheme financed by the Imperial Council of Agricultural Research.

Experiments in the permanent manurial plots disclosed that a mixture of nitrogen, potash and phosphoric acid gave the best results. Lime had beneficial effects on all phosphates, but it gave satisfactory results only in the presence of a full dose of phosphoric acid. Cattle manure gave better results when supplied in rows than when broadcast. A mixture of ammonium sulphate and oil cake was, however, found to give similar results.

In planting trials, the crown end of the tuber gave better results than either the lower half or the whole tuber. Storage experiments showed that the best results were obtained when tubers were allowed to sprout once during the period of storage, without greening.

ASSAM. At the Upper Shillong Experimental Farm attempts to select strains resistant to late blight were not successful. Experiments were designed

to test the effect of manures on potato. This year's results were, on the whole, confirmatory and showed that a combination of Niciphos and sulphate of potash in higher doses works best. A preliminary experiment to test the relative effects of compost prepared at the farm and cowdung did not give conclusive results.

BOMBAY. Experiments at the Cold Storage Research Station, Ganeshkhind, showed that the longer the period for which tubers were kept at ordinary temparature after harvesting, the lesser the subsequent period of dormancy at 40°F. Tubers kept at 35°F., however, remained dormant irrespective of the time when they were stored. Further work on the respiration of tubers, accumulation of sugars, etc. is in progress.

PUNJAB. The chief centre of investigation is the Kangra district while part of the work is also being done in the Murree hills. Of the imported varieties, Majestic and Up-to-date appear to suit the Kulu valley best, while Factor is the most promising variety in the Murree tract. At Palampur, the variety known as Kangra Local seems to give the best yield.

MYSORE. The crop at this place was poor and severely attacked by ring disease and by the Epilachna pest. It is, therefore, considered advisable that trials of this crop should be made at a place more favourable than the Hebbal farm.

ORISSA. Work on the growing of a second crop of potato has been taken up. Storage experiments conducted at Udayagiri, Pottangi and Cuttack farms gave encouraging results.

Introduction of improved varieties

Fifteen successful varieties were grown in the Upper Shillong Experimental Farm for issue to the cultivators.

16. Beans and Pulses

The total area under gram (*Cicer arietinum*) during the year was 12·96 million acres as compared to 15·74 million acres of the previous year. The figures are, however, incomplete, as acreage in Mysore is not available. The decrease in area is mostly in Delhi and the Punjab, which may be attributed to famine condition in the various districts of the Punjab.

The Punjab Department of Agriculture has been able to evolve some blight-resistant varieties of gram, and thus will be saving lakhs of acres of gram in the province from the ravages of the fungus.

Cytological work and effect of Colchicine and vernalization work was also in progress at Delhi on this crop.

The areas important for gram cultivation are the United Provinces, the Punjab, Bihar, Hyderabad and the Central Provinces and Berar. The total estimated out-turn was 2·92 million tons.

In the PUNJAB, considerable attention is being paid to F 8 as it combines in itself the resistance to gram blight and desirable colour. The seed produced amounted to 1,235 mds., and it will be multiplied next year. Extensive research is being carried out not only to select from present bulk crop strains

which may prove higher yielders but is also being crossed with some of the high yielding strains of the province to evolve a new type combining resistance of one with the yield of the other.

At PUSA, type 17·25 and 58 yielded higher than other types. Gram seed was treated with Colchicine for varying periods. The seed treated with concentrations for short periods showed a decided thickening of root tips after 24 hours treatment, while those immersed in higher concentration and for longer period showed a shrivelling and browning of the tips. The tetraploids showed increased vigour with larger leaflets and flowers. Vernalization experiments were also done and gram was found to be a long day crop and chilling had no effect under long day conditions.

In the CENTRAL PROVINCES AND BERAR, fixed crosses between type 28 and wilt-resistant Karachi gram were under preliminary test.

In BOMBAY, types, 816, 693, early types and 822, a late variety, have given good results. Nipping at flowering was found to be significantly superior to the local practice of nipping after flowering. If the cultivators do not care for tender tips for vegetable after flowering, increase in yield can be obtained as found in all the last three seasons.

In BENGAL, Sabour 4 and Pusa 58 are still being recommended.

Pigeon Pea (*Cajanus indicus*)

At Pusa a wilt-resistant strain has been isolated from Pusa 69. A number of polyploids were obtained by the use of Colchicine and studied cytologically. A three factor experiment on split-plot design was also arranged with pigeon peas. It was observed that (*a*) closer spacings gave higher yield, (*b*) the middle of June to the middle of July was found to be the best time of sowing, and type 69 was found to be the best as regards its taste.

In MADRAS, some of the strains have given 62 per cent more yield than the control.

In BENGAL, 163 types were under study. In the UNITED PROVINCES 139 types were grown. Type 132 has been found to be superior to early type 3. In the CENTRAL PROVINCES AND BERAR crosses between P 52, wilt-resistant and 80 and E B 3 and E B 3×E B 38 were grown in wilt-infected area. A wild perennial variety was found to be highly resistant to wilt. It was crossed with E B 3 and E B 38. In BOMBAY and ASSAM some work is also being done on these crops. In Bombay type 84 yielded the best.

Kalais (*Urid, Phaseolus radiatus*) and *mung* (*Phaseolus mungo*)

In BENGAL seed of promising types was further multiplied for trial next year. In the UNITED PROVINCES type 12 in *urid* has been selected and will be further tested before it is released for distribution. In *mung*, these will be tried at Kumaun for selection of suitable varieties. In the CENTRAL PROVINCES AND BERAR classification work is in progress. In BOMBAY some work is also being done. At PUSA most of the cultures suffered greatly due to high temperature and heavy winds which resulted in poor crops. Seed of promising types of *urid* was multiplied and released for distribution.

Soya beans (*Glycine hispida*)

In the Central Provinces and Berar types 53 and 59 gave significantly better results. At Pusa single plant selections were made and their characters studied. In Assam some preliminary work is in progress.

Guara (*Cyamopsis psoralioides*)

In the Punjab, the year was the driest one experienced. It was observed that *guara* was most drought-resistant. *Bajra* came next to *guara*.

Cowpeas (*Vigna catiang*)

In Madras, two crops were raised and selection work is in progress. In Cochin, five types have been evolved, one of which is very prolific.

Garden Peas (*Pisum sativum*)

Peas are of considerable importance during the cold weather for food as well as for fodder. These are of importance in the United Provinces, Bihar, Orissa, Bengal and some tracts of the Punjab and Bombay. Different types are being classified at Delhi. In Madras selection work is in progress.

Lentil (*Lens esculenta*)

At Pusa promising types and hybrids of Pusa lentil were grown and studied. In Bengal lentil 5 is being recommended.

CHAPTER III

RECENT DEVELOPMENTS IN TOBACCO PRODUCTION AND MARKETING*

TOBACCO is an important cash crop. India produces about one-fourth of the tobacco in the world. Normally the United States of America stand first among the tobacco-producing countries; but since 1932-33 the production of tobacco in India has exceeded that in the United States. Though India now competes with the United States of America for the first place in tobacco production, yet her crop is almost entirely used for home consumption, only 2 per cent of the total production being exported to other countries. On the other hand, India imports unmanufactured tobacco from the United States.

The total area under tobacco in India based on the average of the seasons, 1929-30 to 1935-36, is about 13·5 lakhs of acres. The average annual production for the same period is estimated at nearly 5·75 lakh tons, valued at about Rs. 17½ crores. If manufactured tobacco products are included, the total value is roughly about Rs. 48 crores. It is, therefore, clear that even a small increase in price owing to better marketing will add considerably to the cash income of producers. The area and production of tobacco in India during 1938-39 are estimated at nearly 14·3 lakh acres and over 5·86 lakh tons (1,313 million lb.) respectively.

The tobacco acreage is concentrated in five distinct zones, namely, north Bengal, the Charotar (Bombay Gujarat), Nipani (Bombay), Guntur (Madras) and north Bihar.

Seventy-eight per cent of the area under tobacco is found in British India and the rest in Indian States. Four provinces, viz. Bengal, Bihar, Bombay and Madras, account for a little over four-fifths of the total area in British India and over three-fifths of the all-India area. Bengal leads in tobacco area and contains almost 22 per cent of the total tobacco acreage in India. Madras comes second with 19·5 per cent. This is followed by Bombay with 11·2 per cent, Bihar and Orissa 10·6 per cent and the United Provinces and the Punjab with 6·2 and 5·2 per cent of the Indian total respectively.

Tobacco is used in many different ways in India. The chief commercial types of tobacco are cigarette, cigar, cheroot, *bidi*, *hookah*, chewing and snuff.

The principal types of cigarette tobacco are the Virginia and Country (*Natu* or *Desi*). Adcock and Harrison's Special are the chief Virginia varieties, the latter being by far the most important. Harrison's Special has almost entirely displaced Adcock. The plant is taller than the Adcock, more vigorous, and stands high temperatures better. The leaves develop a better yellow colour in curing and this colour keeps better during storage. The yield obtained is also higher than from Adcock. Trials are also being made with the varieties Gold Dollar and Bonanza. The cultivation of Virginia tobacco is confined almost entirely to the Guntur district (MADRAS) and MYSORE. Small

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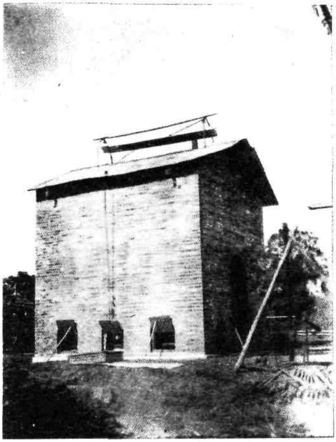
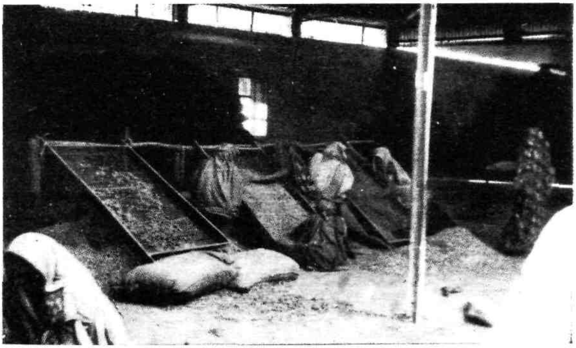
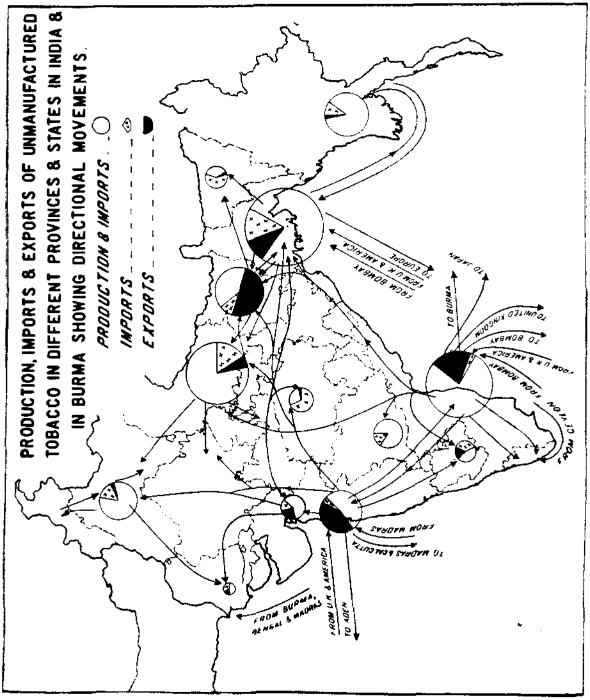


A typical flue-curing barn



Interior of a *Bhuki* factory in the Charotar area showing the sieves used in the preparation of *bidi* tobacco mixtures


PRODUCTION, IMPORTS & EXPORTS OF UNMANUFACTURED TOBACCO IN DIFFERENT PROVINCES & STATES IN INDIA & IN BURMA SHOWING DIRECTIONAL MOVEMENTS.
PRODUCTION & IMPORTS
IMPORTS
EXPORTS
FROM BOMBAY
FROM U.K & AMERICA
TO EUROPE
TO JAPAN
TO BURMA
TO UNITED KINGDOM
TO BOMBAY
FROM U K & AMERICA
FROM BOMBAY
FROM CEYLON
FROM MADRAS
TO MADRAS & CALCUTTA
FROM U.K & AMERICA
TO ADEN
FROM BURMA, BENGAL & MADRAS

areas ranging from 80-100 acres are grown in Satara (BOMBAY), and Saharanpur and Jhansi in the UNITED PROVINCES. SIND used to grow about 250 acres, but the cultivation has now practically disappeared. Fresh trials are, however, being made with some of the Virginia varieties and their hybrids at the Agricultural Research Station, Sakrand. In the Guntur district, the area under Virginia tobacco has increased from 50,000 acres in 1936-37 to 99,000 acres in 1938-39. In Mysore, the area under Virginia tobacco during 1938-39 was estimated to be 4,000 acres. The total production of flue-cured Virginia tobacco in India during 1938-39 was estimated at a little over 45 million lb. In previous years North BIHAR used to produce a fairly large quantity, but the cultivation is now being given up in some parts owing to unsatisfactory flavour. Country tobaccos such as Thokkaku (narrow leaf with tendril-like tip), Desi Vali (moderately narrow leaf) and Dakshinarthi (broad leaf) grown in Guntur district, Bonri (thick and dark leaf) or Chhuria (medium and yellowish brown leaf) grown in Muzaffarpur, Bihar and Bispat (the lowest leaves near the ground) of Jati tobacco of Bengal are also used in the manufacture of cigarettes, pipe and shag tobacco. The country (*Natu*) tobacco of Guntur is, however, more important than these others for cigarette manufacture. The leaf is moderately thin in texture. It has a pleasing aroma of mild or neutral strength and its colour ranges from light to dark brown. The light and medium coloured grades are used in the manufacture of cheap cigarettes, while the darker grades are sold for pipe and shag tobacco.

Cigar leaf is produced to a small extent in BENGAL and MADRAS. The leaf is brown to dark brown in colour. It has thin texture and strong flavour. The important varieties are Pennsylvania, Sumatra and Burmese Havana in the Rangpur district of Bengal and Usikappal grown in Trichinopoly and Coimbatore districts of Madras. Jati tobacco grown in north Bengal is largely used in Burma for the manufacture of cheroots. The Bhengi variety is the one mostly used for this purpose. The cured leaf of Jati is greenish brown in colour, medium in texture and strength. The varieties Monnakappal, Usikappal, Meenampalayam, grown in Madras and Coimbatore, are also used for cheroots. The colour of the cured leaf is dark brown to almost black, and the texture is thin to medium.

Bidi tobacco is principally grown in Gujerat and the Nipani area of the BOMBAY Province and to a small extent in MYSORE. The cured leaf from Gujerat is greenish to yellowish brown in colour, thick in texture and of medium strength, while the cured leaf from Nipani is from yellowish to dark brown, sometimes with dark spots, thick in texture and strong in flavour. The principal varieties of *bidi* tobacco grown in Gujerat are Gandiu, yielding a broad, thick and rather strong and coarse leaf, Piliu, which gives a narrower and shorter leaf, strong in aroma, Keliu, which yields a long and broad leaf, thick in texture and strong in flavour, Movadiu having greenish yellow and brown leaves and Shengiu with long, narrow and thin leaves. The principal varieties of *bidi* tobacco in the Nipani area are Mirji, Nipani, Sangli and Jawari. The *bidi* tobacco grown at Nipani is considered to be stronger than that from Gujerat. The *bidi* leaf produced in Mysore is yellowish brown in colour, medium in texture and strength.

Calcuttia grown in the United Provinces, Delhi and the Punjab is largely used for the *hookah*. The Peshawari variety grown in the North-West Frontier

Province and Motihari of north Bengal are considered to be strong *hookah* tobaccos. The Jati tobacco grown in Bengal, and *desi* in north Bihar, the United Provinces and the Punjab are also used for the *hookah*. The Vilayati variety of Bihar is also primarily used for the *hookah*. The cured leaf of Calcuttia is medium to thick and coarse in texture, greenish brown in colour and strong and pungent in flavour. The Peshawari leaf is greenish brown in colour, thick and coarse in texture and stronger and more pungent in flavour than Calcuttia. Motihari of Bengal is of two kinds, namely Melapat (leaves spreading) and Jorapat (leaves not spreading). The better quality leaves (usually middle leaves) of Melapat are used for chewing, while the rest and the whole of Jorapat are used for the *hookah*. The leaf is greenish brown in colour, thick and wrinkled in texture and strong in flavour. The cured leaf of Vilayati is somewhat smaller and develops a darker colour than Motihari. The cured leaf of *desi* tobacco from Bihar is yellowish brown in colour and medium in texture. It is mild in strength but sometimes has an earthy flavour. In the United Provinces, the *desi* tobacco though primarily used for chewing is sometimes used for the *hookah*. The cured leaf is long and narrow, greenish to dark brown in colour, thin texture and mild in strength. The leaf of the *desi* variety of the Punjab is greenish brown in colour, thin to medium in texture and of medium strength.

There is no variety grown solely for chewing and snuff except in the North-West Frontier Province where to some extent a variety is grown for snuff alone. Its cured leaf is greenish brown in colour, thick in texture and strong in aroma. The *desi* variety grown in Bihar is used for the *hookah*, chewing and to some extent for cigarettes. The *desi* tobacco of the United Provinces and the Jati of Bengal are also used for chewing. The tobacco grown in Mysore State is used partly for chewing, snuff and *bidis*. Generally a leaf with medium to thick texture and pungent aroma is selected for chewing and snuff. There are, however, certain varieties which are used only for chewing and snuff. Thus the Puchakkal tobacco grown in the South Kanara district of Madras is used only for chewing and snuff. The leaf is dark brown in colour and of medium texture. Meenampalayam tobacco, grown in Coimbatore district, is considered to be one of the best chewing tobaccos in South India. The leaf is dark brown in colour with a whitish bloom and thick in texture. The Kalichopadia and Judi tobacco grown in Gujerat are also used largely for chewing and to a small extent for snuff. The leaf of Kalichopadia is almost black in colour and thick in texture. The Judi is brown in colour and medium in texture. The leaves, well developed and thick in texture with pungent aroma and biting taste from Motihari and Vilayati varieties and some times from Calcuttia, are selected for chewing and snuff. The cheaper grades of snuff are usually made from the tobacco dust of any variety.

The exports of unmanufactured and manufactured tobacco from India by sea during 1937-38 were over 52 million lb. valued at nearly 200 lakhs of rupees. Unmanufactured tobacco is by far the most important in the export trade, the quantity exported during 1937-38 being nearly 42·46 million lb. valued at over 117 lakhs of rupees. The exports show an upward trend since 1935-36 when the quantity shipped was 27·75 million lb. as against 24·57 million lb. in the preceding year. The important destinations are the United Kingdom, Aden and Dependencies, the Netherlands and Japan. Indian Virginia flue-cured

tobacco is assuming increasing importance in the United Kingdom which imports from India over one-fourth of the unmanufactured tobacco imported into Britain from Empire countries. The quantity of unmanufactured tobacco exported to the United Kingdom during 1937-38 was 21·2 million lb. The Japanese demand is confined to the sun-cured *Natu* (country) tobacco produced in the Guntur area of Madras Province. *Bidi* and smoking tobacco are sent to Aden. The exports to the Netherlands are mostly in lower-grade leaf such as Bishpat (sand leaves) of Jati tobacco grown in Rangpur district in Bengal and scraps of Virginia and country cigarette tobacco grown in Guntur. The quantity of unmanufactured tobacco shipped to China from India during April to November, 1939, reached the figure of 17·7 million lb. which was 5·3 million lb. more than the quantity exported to the United Kingdom during the same period. Small quantities of Indian Virginia flue-cured strips amounting to about 940,000 lb. were even re-exported from the United Kingdom to China during July 1939. The Chinese demand is, however, confined to lower grades of cigarette tobacco. Re-export trade from India, however, is exceedingly small and consists principally of unmanufactured tobacco, cigarettes, pipe and cut tobacco. Unmanufactured tobacco is re-exported principally to Aden and Dependencies; but small quantities are also shipped to the United States of America. Manufactured tobacco is exported chiefly to the United Kingdom, Aden and Dependencies, Ceylon, Straits Settlements, Bahrein Islands, Muskat Territory and Trucial Oman and China and Japan.

The exports by land frontier routes adjacent to the North-West Frontier Province, Kashmir, the United Provinces, Bihar, Bengal and Assam are almost wholly in *hookah* and smoking tobacco. The quantities of exports from India during 1936-37 were 9·2 million lb.

Imports into India consist of unmanufactured tobacco, cigarettes and other sorts of tobacco products. The imports of unmanufactured tobacco into India during 1937-38 were about 6·6 million lb. valued at Rs. 44·78 lakhs. Nearly 45 per cent of the imports of unmanufactured tobacco by sea consisted of the American virginia flue-cured leaf for use in the manufacture of cigarettes either received directly from the United States of America or in the form of re-exports of American leaf from the United Kingdom. Nearly 94 per cent of the cigarettes imported by sea into India were received from the United Kingdom. The quantity of imports of cigarettes from the United Kingdom during 1937-38 was nearly one million lb. valued at over Rs. 34 lakhs. The imports of cigarettes have, however, been falling.

The imports by land frontier routes are mainly in *hookah* tobacco. The quantity imported during 1936-37 was 8·2 million lb.

Over 1,000 million lb. of tobacco are consumed annually in India. There is no definite statistical information available in regard to the consumption of locally-produced cigarette tobacco in the manufacture of cigarettes in India, but it is estimated that out of 22 to 23 million lb. of tobacco leaf annually used by all the cigarette factories, about 20 million lb. of tobacco are local. The balance of 3 million lb. (13 per cent) is foreign leaf imported almost wholly from the United States and United Kingdom. The general trend of consumption in cigarettes appears to be on the rise. At the beginning of 1929 the consumption was estimated at 6,500 million cigarettes per annum, while the pre-war annual average consumption was estimated at about 1,060 million cigarettes.

The number of cigarette factories rose to 22 in 1935 from 9 in 1929. The annual production of cigarettes in the whole country at present is estimated at about 7,500 million cigarettes valued at nearly Rs. 6 crores.

About half a million lb. of tobacco is used in the manufacture of cigars annually and the number of cigars manufactured at present is about 30 million valued at about Rs. 15 lakhs per annum. The consumption of cigars and cheroots appears to have declined considerably in the past few years. The main reason for this is the growing popularity of cigarette smoking among the people. The production of cigars and cheroots is almost entirely confined to the Madras Province where there are about a dozen and half large factories. Trichinopoly is an important centre of production and has about a dozen factories. The average annual output of cheroots in India is estimated at 90 to 92 million lb. or about 18,500 million cheroots valued at over Rs. 9 crores. Cheroot-making is a cottage industry in the Madras Province, part of Mysore and in Hyderabad. Trichinopoly is the largest manufacturing centre. In Burma, about a thousand million strong cheroots containing about 24 million lb. of tobacco are manufactured annually. The average annual output of mild or torch cheroot is a little over 6,000 million cheroots for which about 58 million lb. of tobacco is used. The total value of the cheroots manufactured is estimated at Rs. 8·7 crores.

The most important *bidi* manufacturing centres in the country are located in the Central Provinces. The popular and widely used *bidi* tobaccos are those grown in Gujarat and Nipani areas of the Bombay Province. The material used for wrappers is obtained from leaves of forest trees called locally *tumuki* or *temburni* or *tendu* (*Diospyros melanoxylon* or *Diospyros Ebenum*) which grow wild in Central India, the Central Provinces, the United Provinces and Hyderabad. The output of *bidi* in the Central Provinces factories alone is estimated at 5 crore *bidis* per day. The estimated consumption of *bidi* in India in terms of tobacco is 68·7 million lb. The total value of the manufacture is estimated at Rs. 7·5 crores.

The annual production of *hookah* tobacco in the country is estimated at over 1,300 million lb. valued at about Rs. 9·6 crores. Almost two-fifths of the production is confined to the United Provinces.

Over 156 million lb. of chewing tobacco leaf valued at a little over Rs. 3 crores is annually consumed in the country. About 84 per cent of this quantity is consumed in raw condition. The annual average production of manufactured chewing tobacco is about 25 million lb. valued at about a crore and five lakhs of rupees. The United Provinces and Delhi are the most important for the manufacture of chewing tobacco.

The annual average production of snuff in India is estimated at 21·7 million lb. valued at about a crore and a half rupees. Madras, the Punjab and the North-West Frontier Province together account for a little less than one-third of the total production of snuff in the country.

It is estimated that about 835 million lb. of tobacco is consumed in the form of *hookah*, chewing and snuff in India.

Marketing surveys have shown that prices of good quality tobacco are rising, while prices of low-grade tobacco are steadily falling. It need hardly be emphasized that quality is the most outstanding factor of importance in the marketing of tobacco. High quality not only results in higher prices for pro-

ducers, but ensures wider markets for Indian tobacco both in India and abroad.

The quality factors of the different types of tobacco, namely cigarette, cigar, cheroot, *bidi*, chewing and *hookah*, are entirely distinct and are not generally known to the producer. The problem of improving the quality of Indian tobacco cannot therefore be left to individual growers. On the other hand, organized direction and control are necessary for raising and maintaining the general level of quality.

Some attempts in this direction have already been made. The Indian Tobacco Association at Guntur and the Bihar Tobacco Association in Darbhanga district have been organized through the efforts of the marketing staffs. These associations among other objects seek to educate the grower in the production of the right quality of tobacco. Voluntary effort of this nature has, however, its limitation both in regard to the time taken to attain its aims and as regards the area covered. It, therefore, seems desirable that legislative measures should be introduced early to secure more direct control over the quality of tobacco produced in different parts of the country.

A great deal of harm is done to the reputation of Indian tobacco by putting on the market low quality produce. Defective leaf of poor quality is cured and mixed along with good quality leaf in such a way as to lead to unfair competition and to disappointment on the part of the buyers. There is, however, no reason why the present export of 'scraps' to the Netherlands should not continue and be expanded, but such tobacco should be duly marked at the time of export to distinguish it from high-quality cigarette tobacco. In the absence of any clearly defined grades, the comparison of prices becomes impossible and opens the way to malpractices. Buyers and sellers from the growers onwards should therefore be induced and even compelled to adopt standard grades and methods of packing.

So far as cigarette tobacco is concerned, AGMARK grades for Virginia and country leaf, (both flue-cured and sun-cured) have been prescribed under the Agricultural Produce (Grading and Marking) Act, 1937. The Indian Tobacco Association at Guntur have made themselves responsible for preparing seasonal standard samples of the various grades which are sent to the High Commissioner for India, London, for exhibition and distribution to the trade in England and other countries. Many of the exporters have adopted the AGMARK system of grading and marking their goods, but much more needs to be done to ensure the wider adoption and more general use of the prescribed grades. It appears that the practical adoption of such grades might be ensured through a system of control over exports on the basis of standard grades.

In 1937-38, 300 bales (about 75,000 lb.) of graded tobacco were exported to the United Kingdom as a trial consignment. The general response from the trade in the United Kingdom was only fairly satisfactory, and owing to small quantities the exporters from Guntur were not able to get a separate quotation for the AGMARK standard bales. At present it appears to be the practice of the London brokers and leaf merchants to offer to the Guntur exporters a flat rate on the whole consignment of the Guntur exports without making a distinction between bales graded according to standards and those on ordinary grades. During the tobacco season 1938-39 the Indian Tobacco Association, Guntur, again provided typical samples of the different standard grades of cigarette leaf to the High Commissioner, London, for distribution to the trade

in England and other countries and individual members exported to the United Kingdom 626 bales of graded tobacco valued at about Rs. 50,000. Unfortunately, this example was not followed by the trade generally and several consignments of poor quality leaf were exported which spoiled the market. This experience has been valuable in this respect that the whole trade is now practically unanimous on the need for exporting in future only on the basis of the AGMARK grades.

The grading of tobacco leaf was extended to indigenous varieties on an experimental basis during 1938-39. In Bihar, nearly 30,000 mds. of *desi* leaf valued at Rs. 1,30,000 were purchased for which increased cash returns of 13·1 per cent were realized by producers. At Haragacha in Rangpur district in Bengal also, about 700 mds. of Jati and Motihari varieties were graded during the season of 1938-39.

CHAPTER IV

COMPOSTS AND COMPOSTING*

INCREASING interest is being shown by various agricultural departments, municipalities, public health authorities and farmers in India in the preparation of compost manure from farm and town wastes. A large number of coffee, tea and sugarcane estates have taken to composting as a part of their regular programme of field operations, and active propaganda is being carried on by agricultural departments in the provinces in order to persuade farmers on small holdings to take to compost-making.

In MADRAS, composting of night-soil with municipal rubbish was successfully demonstrated in the second circle. Prodattur, Hospet and Nellore municipalities and Rajampet and Pattikonda Panchayat Boards have taken to the manufacture of composts. In the third circle, the conversion of all habitation wastes, cane trash, groundnut husk and other organic wastes into compost was advocated, and the Bangalore method of preserving manure was adopted in Palni taluk. The total number of compost pits maintained during the year was 5,352 as against 3,063 in the previous year. At Prodattur 54,000 c. ft. of compost were prepared by utilizing the whole of the rubbish and night-soil of the municipality. The municipality obtained a net income of Rs. 1,200 which was about three times the income obtained by sale of refuse in previous years.

Compost-making was taken up as an important demonstration in rural areas of BENGAL. Apart from using miscellaneous vegetable waste products, the possibilities of utilizing water hyacinth—an easily available and valuable ingredient for compost-making—were practically demonstrated. The total quantity of manure that was manufactured from various waste products, including water hyacinth, amounted to about 56,087 mds.

Eight hundred and forty-seven compost heaps were made in ORISSA on cultivated land through agricultural overseers in charge of propaganda work.

In TRAVANCORE, compost was prepared in the Paddy Farm, Nagercoil, out of the sweepings and rubbish from the Vadaseri market and in the Fruit Farm, Cape Comorin, out of dry leaves and other waste material. Composting was demonstrated at some of the rural centres started during the year. Temple refuse containing a large quantity of plantain leaves was successfully composted at Nagercoil. The municipalities at Quilon, Nagercoil and Trivandrum continued to compost night-soil with street sweepings on the lines recommended by the agricultural department.

Jungle material collected outside tea estates, as well as sunflower and mugwort grown on waste land have been composted with success on several tea estates in SOUTH INDIA.

Active propaganda for the utilization of all kinds of farm refuse by converting them into compost manure was continued in BOMBAY with the result that 2,222 cart-loads of manure were prepared in the Bhusaval section in 42

*The assistance of Dr C. N. Acharya, M.Sc., Ph.D., F.I.C., in the preparation of this chapter is gratefully acknowledged.

villages on 55 farms. Compost-making was demonstrated at 15 places in west Khandesh and at ten places in Nasik.

About 150,000 mds. of compost per annum are being prepared on Government farms in the UNITED PROVINCES. About 7,000 mds. of compost were made at the INSTITUTE of PLANT INDUSTRY, INDORE, as part of the farm routine.

Methods of making compost. A great deal of attention has been devoted at BANGALORE to a comparison of the methods at present in use for the composting of farm and town wastes and to devising methods which would combine biochemical efficiency with simplicity of manipulation and economy of labour and water supply. The hot fermentation process of composting has been found to be specially suitable for the composting of night-soil with street sweepings and also for composting the mixed wastes of small farms. Losses of nitrogen and organic matter were found to be particularly low in the above method.

The Indore method was adopted with success on a number of tea estates in SOUTH INDIA to deal with jungle loppings and other green matter. Simplified modifications of the Indore technique have been found preferable in BOMBAY and the UNITED PROVINCES. The Institute of Plant Industry, Indore have republished in leaflet form the details of their methods of composting farm wastes.

Cost of compost-making. Labour charges for the preparation of compost by the Indore process has been estimated at the Institute of Plant Industry, INDORE, to come to 8½ as. per cart-load of finished compost (½ ton). From about 350 cart-loads (1 cart-load=10 mds.) of mixed wastes were obtained 150 cart-loads of compost in a year, with the help of all the dung from one pair of bullocks and half the earth from the cattle shed floor soaked in their urine.

The experience at Poona and Dharwar has been that the labour charges come to Rs. 2 to Rs. 2-4 per ton of compost prepared by the Indore process.

The expenses of composting, by a simplified procedure, came to 12 as. per cart-load of manure (½ ton) at the Bhadgaon Farm and at Pachat (BOMBAY). The cost of preparation of compost at BANGALORE by the hot fermentation process came to 8 as. per ton of manure.

The quantity of compost prepared per pair of bullocks kept on the farm, varied from 400 to 700 mds. per year, on Government Farms in the UNITED PROVINCES (depending on the quantity of refuse available) with an average of 550 mds. or about 20 tons per year per pair of bullocks. The cost of composting went up in some cases to 10 pies per maund or about Rs. 1-7 per ton of manure, depending on the wages of labour employed. A simplified Indore technique was adopted.

The trials carried out at ALLAHABAD showed that 12 cart-loads of night-soil daily yielded about 4,300 c. ft. of manure per month.

Effect of composts on crops. Pot and field experiments carried out in MADRAS at the Hagari Dry Farming Station showed that compost, applied at 50 lb. nitrogen per acre, gave significant increases in yield of *Setaria* and sorghum. Cotton following *Setaria* was markedly benefited by the application of compost manure to *Setaria*. Both the direct and residual effects of compost exhibited themselves fully in years of good rainfall.

Experiments carried out at BANGALORE showed that composts prepared from night-soil and street sweepings by the hot fermentation process showed a much higher manurial value on *ragi* and sorghum than composts prepared

The effect of compost on *jowar* (*Andropogon Sorghum*). The plot on the left has been treated with compost manure.

from farm refuse. Both manures were applied on equal nitrogen basis. When, however, night-soil was composted with street sweepings aerobically, there was considerable loss of nitrogen and the manurial value per ton of compost became poorer.

Trials with composts on tea carried out in ASSAM at the Tocklai Experimental Station showed that digging into the soil of uncomposted refuse materials along with dung or urine or Nicifos used as starter, gave as good and in several cases better results than the application of composts prepared from the above materials. In several cases, tea did not show a significant response to the application of compost manure.

Compost prepared from town refuse and night-soil at Prodattur in MADRAS was tried on *ragi* and gave 17 per cent increase of grain and 7 per cent increase of straw over the no-manure plots.

Comparative trials of compost and farmyard manure conducted in BOMBAY on Bhadgaon Farm showed that composts properly prepared were equal to farmyard manure as a basal manure from cotton and other crops.

Compost prepared from habitation wastes gave an increased yield of maize to the extent of 35 per cent over no-manure plots in BIHAR.

Further systematic work is necessary with a view to evaluating the manurial value of composts when (*a*) prepared by different methods, (*b*) obtained from different types of raw materials, (*c*) applied to different crops, and (*d*) used on different types of soils under different sets of climatic and cultural conditions. The absence of properly laid out experiments is a serious drawback in assessing the value of the evidence at present on hand on the above points.

CHAPTER V

RESEARCH IN CROP PRODUCTION*

1. Soils and fertilizers

THE year under review marked a period of expanding activity in India in the study of soil conditions and of questions relating to the efficient manuring of different crops. The inter-relationship between soil type and the vegetation best suited thereto and the influence of climatic factors on this inter-relationship are also attracting attention. Investigators on the manuring of crops are paying special attention to the economics of such applications. It is being increasingly recognized that the next stage in the further improvement of crop yields in India and in decreasing cost of production lies not so much in evolving fresh varieties as in improving soil fertility through efficient soil management and the judicious use of manures.

Soil classification

1. *Soil maps.* At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, preliminary soil map based on agricultural and colour nomenclature has been completed. This preliminary map classifies the soils of India into eight main prevalent categories—(1) alluvial, (2) coarse alluvial, (3) red soils lying on metamorphic rocks, (4) laterite soils, (5) black soils, (6) deep black soils, (7) light soils on trap rock, (8) deep black alluvial soils. The alluvial soils of extra-peninsular India are further divided into the Indus alluvial, the Gangetic alluvial and the Brahmaputra alluvial soils. Another map based on climatic differences was also prepared but was still under check with reference to single value climatic factors and the normal geographical distribution of the major crop zones. A third map was prepared by plotting the relative nitrifying efficiencies of the surface soils. This shows a clearly demarcated central belt of deficient nitrification running north-east to south-west across the country at the boundary which divides peninsular and extra-peninsular India.

A beginning was made in the genetic classification of the soils of the PUNJAB. For the purpose of this classification, the province was divided into nine climatic belts on the basis of rainfall and temperature.

2. *Soil genetics.* The soils of India offer a distinct contrast to those of many other countries in that they are very old, fully mature and do not show

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(1) Rao Bahadur B. Viswanath, F.I.C., F.C.S., Director, Imperial Agricultural Research Institute, New Delhi.

(2) Dr L. A. Ramdas, M.A., Ph.D., Agricultural Meteorologist, Poona.

(3) Dr S. Ramanujam, D.Sc., Second Economic Botanist, Imperial Agricultural Research Institute, New Delhi.

(4) Dr G. Watts Padwick, M.Sc., Ph.D., D.I.C., Imperial Mycologist, Imperial Agricultural Research Institute, New Delhi.

(5) Dr H. S. Pruthi, M.Sc., Ph.D., Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi.

(6) Dr H. K. Sen, M.A., D.I.C., D.Sc. (Lond.), F.N.I., Director, Indian Lac Research Institute, Namkum, Ranchi.

in many cases the pedogenic processes and the close relationship between the soil and its rocky substratum. The weathered materials in most cases have been transported to great distances by various agencies. The great majority of soils are of ancient alluvial origin and the so-called Indo-Gangetic alluvium comprises almost the entire portion of extra-peninsular India occupying the greater portion of Sind, Northern Rajputana, the Punjab, the United Provinces, Bihar, Bengal and Assam. This area may again be divided into three main divisions, the Indus alluvium, the Gangetic alluvium and the Brahmaputra alluvium. These can further be divided into sub-montane and plains regions. These alluvia were originally derived from the rocks of the Himalayan range of mountains.

Peninsular India represents the ancient tableland, a large area of which is covered by the ancient and the earliest formed gneisses and schists. A colossal volcanic erruption some time after the Vindhyan epoch brought the Deccan trap rock into being. In India the unique monsoonic division of the year into dry and wet periods and the high temperatures that prevail, considerably influence the character and the sub-aerial denundation of the surface of the country. Compared to the soils of the temperate zones, the aerial and soil temperatures in India are higher by as much as 10° to 20° C. or more and, therefore, all chemical reactions involved in the soil and plant processes proceed many times more intensively. The high temperatures and humidity function so intensively that chemical decomposition follows almost at the heels of rock disintegration and is the more conspicuous feature of the soil processes in the plains. The result is that irrespective of the nature of the original rocks from which the soils are derived, the forward reactions of normal weathering and the secondary reactions resulting from the shifting equilibrium on the basis of solubility and interactions have tended towards the direction dictated by the climatic complex of the locality. The soils of the arid zone are characterized by high base saturation and both calcium and sodium are in excess over magnesium and potassium. About 80 per cent of the silica is in the soluble form. The soils are of a light pink colour due probably to their beirlg residues of syenitic rocks and by interaction with colloidal silicic acid which is not removed owing to scanty rainfall a thin coating of iron oxide is formed on the silica particles. The silica-sesquioxide ratio of 2·91 and kaolinization are indications of maturity. The soils under semi-arid and humid conditions are developed from almost all types of rock systems and are either brown, black or red. It would appear from the analytical data that the soils are not always residues which have survived weathering, but in many cases are adsorption complexes of iron oxides and silicic acid. Those derived from limestones are richer in lime content but more alkaline, as for example the soil from Surat developed from Nummulites and that of Tabiji which is derived from igneous limestones. These soils, developed under semi-arid and humid conditions, contain proportionately greater amounts of silicic acid, consequent on the removal of the bases of the alkali and alkaline earth metals. Base saturation of the silica is lower than in the case of arid soils. Soils developed under perhumid conditions show distinctly the effects of leaching action. Agronomically black and red soils are distinguished and are invested with specific agricultural qualities. The black soils, which are different from peaty and other forest soils rich in organic matter and from the black soils of swamps, are highly siliceous and

the clays contain high amounts of alkalies and alkaline earth bases. A variety of rock systems under semi-arid and semi-humid conditions give rise to these soils. The high silica, alumina ratio (3·39) shows that they are highly Kaolinitic and have adsorbed alkalies to a great extent. The red soils, which are also derived from the same rocks as black soils, have clays with low lime content.

3. *Soil surveys*. A complete soil survey was made of the Dhundi estate (Dera Ghazi Khan district). The soil of the Dhundi estate, except in the riverain tract, differs materially from the soils of most other districts of the Punjab, mainly because of its high clay content which, in the majority of samples analysed, varied from 40 to 60 per cent. The percentage content of sand is correspondingly low when compared with other Punjab soils. The Dhundi soils also contain a high water-soluble salt-content, mainly in the form of sulphates, but this high concentration is counterbalanced by a high proportion of water-soluble calcium. The soil generally contains a high percentage of calcium carbonate, in addition to water-soluble calcium. The soils are deficient in organic matter.

The LAHORE IRRIGATION RESEARCH INSTITUTE have followed up their study of hill soils (PUNJAB). The prevailing types of geological formation in the Kashmir valley are the Panjal traps and Karewas. The blue pine soils and those under silver fir are derived from the Karewas and appear to be very stiff and almost impermeable. The soils belong either to the brown earth group or to immature podsols. On the other hand, deodar soils are mainly derived from the Panjal traps. These were well drained and had a fair distribution of sand, silt and clay, and contained stones of varying sizes which rendered the soils less compact and easier to work than soils under blue pine. Deodar soils belonged to the podsol group.

In BOMBAY, the results of the work done under the soil-fertility surveys in the Godavari Canal areas show that the majority of cane soils have a higher clay, but a lower silt content than the adjacent unirrigated soils, and it is suggested that it is due to a mechanical breakdown of the coarser particles as a result of cane cultivation over an extended period. On the same canal tract, it has been found that the deterioration of cane soils is usually associated with an increase in the carbon-nitrogen ratios in the soils which are found to be in agreement with the results obtained for soils of the Nira Left Bank Canal area. The results of detailed biological studies in both cane and fallow plots carried out over a period of four years have revealed the nature of periodic fluctuations in bacterial numbers and their bearing on the nitrogen cycles in such soils under various irrigational, manurial and cultural treatments. It has been found that as a result of soil exhaustion consequent upon the growing of the cane variety (Co 419) with low manurial applications, the yields of subsequent *kharif* crops were adversely affected. In *chopan* soil profiles, under fallow conditions, alkalization of the surface soil was found to occur in the hot weather due to the upward movement of soluble sodium salts. The cultivation of *shevri* and lucerne on such lands appears to be effective in checking this harmful development.

Four genetically different soil types, viz. red loams, grey brown forest soils, podsols and Wiesenboden, have now been recognized in the soils studied at Chaubattia. Grey brown forest soils and podsols are developed under the

pedological conditions of the locality and, therefore, are generally met with everywhere in Kumaun. Wherever due to the topographical conditions, the climate approximates to that of the tropics, red loams are developed. The Wiesenboden formations are not genetic types. These formations are developed under waterlogged conditions where grey brown forest soils and podsols assume certain peculiar features necessitating their classification under a separate group.

The soils of the area surveyed in COCHIN State contain fair amounts of nitrogen except on the west coast. The supply on both total and available potash is not adequate and the application of the potassic manures is considered desirable. Though the total phosphoric acid content is satisfactory, the percentage of available phosphoric acid is low. The soils are deficient in lime also.

Laterization is very pronounced in some districts of TRAVANCORE and the *soils as a whole appear to be deficient in most of the essential plant foods.* Their lime content, too, is far below the usual limits.

At COIMBATORE, comparative studies of the black soils of the Central Provinces and Madras-Deccan show that they are alike in many respects as the result of their formation from two types of rock similar in mineralogical composition and differ only in Fe_2O_3 content which is higher in the Central Provinces soils. The black soils of the Central Provinces resemble those of the Madras-Deccan with a high clay content and a *p*H of 8·5-8·8 but show no depth distribution of salt in profile. The SiO_2/R_2O_3 molar ratio of the clay complex of the Central Provinces soils was of the order of 2·7-3·0, which was slightly lower than that of the soils of the Madras-Deccan.

4. *Soil profiles.* At NEW DELHI, soil studies are a continuation of those of the previous year designed to obtain comparative data on the development and behaviour of soils under different geological and climatic influences that obtain in different parts of the country. As a first step in these studies, the analysis of soil profiles of uncultivated or virgin soils was commenced some two years ago. The analyses were directed to ascertain the composition of clays which are the final products of rock wethering and the most reactive part of the soil. The analyses of the aqueous extracts of the soils have given useful indications regarding anions and cations which play an important role in the soil solution. Striking differences have been noticed. On the basis of the concentration of water-soluble salts and their depth distribution in the profile, five main groups may be formed. (1) Profiles in which the concentration of soluble salts is the highest at the surface and lowest at the bottom (i.e. 5 ft. to which the profiles have been taken), (2) profiles in which the highest salt concentration is at the surface and the lowest somewhere in the middle of the profile, (3) profiles in which the highest salt concentration occurs somewhere in the middle, while the lowest concentration is either at the surface or at the bottom, (4) profiles in which salt concentration is maximum at the bottom and lowest either at the surface or somewhere in the middle, and (5) profiles with concentration more or less uniform throughout and the total quantities of which are very low. In the profiles of the first group, sodium and chlorine predominate, while in the second, the sulphate radicle is either very low or absent. The third group is characterized by the predominance of either calcium or sodium and sulphate or chloride. The fourth group is characterized by

very high salt concentration, while the fifth contains very low amount of salts. The profiles of uncultivated soils in places of low and medium rainfall do not show much variation in the depth distribution of exchangeable bases. In the arid and semi-arid regions, calcium constitntes 70 to 80 per cent of total exchangeable bases, while magnesium, potassium and sodium together vary between 5 and 15 per cent. In humid and perhumid regions, the exchangeable calcium is lower at the surface than in the deeper layers. If the values for the various constituents are compared with the ratio of rainfall to temperature, the evidence of secondary reaction is evident. The adsorption of Na_2O, K_2O and CaO has taken place under a low rainfall of 8·5 in. per annum, and owing to the chemical stability of the clay complex and moisture deficiency, magnesium silicates have been left comparatively unacted upon. Under 50 to 60 in. of rainfall, aided by the high prevailing temperature, conditions would be favourable for dissociation and the formation of hydrogen clay, which reacting with the soluble electrolytes present in the system forms adsorption systems. The upward movement of the electrolytes will be quite pronounced due to the prevailing high temperature. Under conditions of greater precipitation following intense heat and drying all the cations except MgO move out, the CaO moving the most quickly and easily. This is followed by the entry of magnesium in the clay-complex not only in the adsorbed state but also into the lattice structure. The data so far available on the carbon and nitrogen contents of the profiles show that the ratio of carbon to nitrogen in the surface soils varies from 5·1 to 23·6, though in several cases it is round about 10. The wide ratios are noticeable more particularly in a belt, soils of which exhibit weak nitrifying power as judged by comparative nitrification studies in the laboratory of the Imperial Entomologist. The ratios do not show any striking feature in the various depths in the profile. Considering the carbon-nitrogen ratios in respect to soil and climate, the nitrogen content of the soil would be a function of the mean annual temperature and humidity and would decrease exponentially with increasing temperature. Such a relationship has been extended to organic carbon also. When, however, the available data for surface soils are plotted on the map at the places from which soils were collected, they appear to fall into three distinct regions. Those with ratios between 12 to 20 fall in one region, with ratios 10 to 12 fall in another region, while those with values below 10 form a separate region.

A soil survey of the whole of the Chaubattia (UNITED PROVINCES) orchard at distances 100 ft. apart was completed. On the basis of the horizon character of every profile, a soil map of the orchard has been completed. This shows that profile characters very often change even at distances of 10 ft.

At DACCA, the profile of soils in some of the laterite areas in peninsular, central and eastern India including Buchanan's laterite soils of Malabar were examined. A distinction may be drawn between profiles developed under more or less dry weather with evenly distributed rainfall and those developed under alternating wet and dry periods. In the former case, red loam seems to be formed, as evidence of intense decomposition leading to complete separation of the sesquioxides is absent in the profile, whereas in the latter case laterization appears to take place.

The profile characteristics reported for laterite soils in Southern India, Central Provinces and Orissa, so far observed, are :—(i) disintegration and

decomposition of rock and soil material to considerable depth, (ii) light red colour of the soil material in the surface horizon, (iii) slightly acid reaction of the surface horizon passing into neutral or even slightly alkaline reaction in lower horizons, (iv) a tendency of formation of honeycombed iron crust in surface horizons.

The general characteristics of the profiles of Chotanagpur, so far examined, are :—(*a*) a humus layer of granular structure on the top (up to 1 ft. approximately). In the case of soils where considerable erosion took place, this layer was absent; (*b*) a layer of bright red soil below the humus layer (up to 1 ft. 6 in. approximately). This layer is granular in structure and is often found mixed with gravels; (*c*) the third layer of soil is generally reddish brown in colour and is frequently found mixed with gravels and concretionary nodules, and sometimes with decomposing boulders; (*d*) the fourth layer consists of yellowish white mass, generally sandy in structure mixed with gravels. This yellowish mass probably forms the decomposed parent material; (*e*) the fifth layer generally consists of what is locally known as 'dead rocks' which easily breaks up into pieces at definite stratified layers. This so-called 'dead rocks' seems to be some fossiliferons material; (*f*) finally there is the parent rock.

It is suggested by these workers that the SiO_2/Al_2O_3 ratios of the clay fractions should not be regarded as the chemical index of laterites and of lateritic soils, since clay fractions of most of the soils examined have their SiO_2/Al_2O_3 ratios higher than 2·33. The C/N ratios of soil samples decrease as the depths of the profiles increase. The nature of organic matter of the profile samples cannot, however, be characterized on the basis of these ratios, since the C/N ratios of different profiles do not differ markedly from one another. The variation of total exchangeable bases down the profile do not show any regularity, although there is a marked tendency for the total exchangeable bases to increase as the depth of the soil layer increases. In general, the ratio of exchangeable calcium to the total exchangeable bases expressed as a percentage decreases down the profile. These ratios are often quite low, showing that in such cases exchangeable bases other than calcium predominate. The ratio of exchangeable calcium to the total saturation capacity shows a decrease down the following profiles: Dacca, Raipur, Nilgiri Hills (3,000 ft. and 5,000 ft. a.s.l.). The profiles from Suri show a maximum value at intermediate depth, whilst profiles from Bidar and Himayatsagar show minimum value of ratios at an intermediate layer.

Soil moisture

In BENGAL, the movement of soil moisture under field conditions indicated a gradual increase of moisture-content in the lower layers which attained its maximum at about 2 ft. The moisture-content equilibrium considerably varied from place to place, but the average depth at which the equilibrium moisture zone was situated was almost the same in all cases so far examined.

The rise of water was least in a saline (*bari*) soil from the PUNJAB, being only about 6 in. in a period of three months and beyond, while the water rose to a height of 2 ft. in 15 days in the Poona black cotton soil. The rise was quickest in the case of a normal alluvial soil from the Punjab. Stndies on the

rate of loss of moisture from the surface showed that the loss was inversely related to the rate of rise of water ; it was least in the case of the *bari* or alkaline soil, greater in the case of the Poona black cotton soils and greatest with the normal alluvial soil from the Punjab.

At Hagari in MADRAS, the cause of crop failure in the black soil tract of Bellary district is attributed to the formation of a hard layer 6-9 in. in thickness, below the top 2 in. of friable, loose soil. This hard layer prevents the later-formed and adventitious roots from penetrating into the deeper moist layers of the soil. It also strangulates the tap roots at the base of the stem, thus interfering with the translocation of water and nutrients to the shoot and resulting in reduced growth or complete wilting of the crop. The formation of the above hard layer is conditioned by the amount and distribution of rainfall in any season. In dry years, it forms very early in the life-history of the crop and results in complete crop failure. In favourable years, it forms towards the later stages of plant-life and hastens the maturity of the crop, by reducing water supply. The evolution of short duration varieties, capable of forming an elaborate root-system sufficiently early to circumvent the hard layer when it forms, may be useful.

At Padegaon in the BOMBAY Province, detailed investigations on the inter-relationship of the daily growth, humidity and soil moisture have revealed that with the optimnm soil moisture which is 40 per cent and above, *fluctuations in the humidity determine the rate of growth. As the moisture-content* begins to fall below this figure, humidity is not so very effective.

Pot-culture experiments have confirmed the findings abont the definite contribution from the water-table to the water requirement of the crop in the case of semi and continuous proximity of subsoil water-table. The field investigations into the inter-relationship of water and manure during three years have shown that while better development of the crop and higher tonnages are obtained with increasing doses of nitrogen (up to 300 lb. N per acre) in both the varieties, higher watering (130 in.) has, on the whole, shown no advantage over the lower one (95 in.) for these manurial treatments in the case of POJ 2878 and has actually produced deleterious effects at later stages of growth in the case of Pundia. This variable response of the varieties is mainly due to the differences in their root-system.

Physical properties of soil

The physico-chemical properties of soil samples collected on profile basis from different parts of Bengal and of central and southern India were determined. Examinations were made as to how far saturation with lime at *p*H 7·1 affected the maximum water-holding capacities, maximum xylol-holding capacities and percentages of imbibitional water. It is found that the maximum water-holding capacity increases on saturating the soil with lime at *p*H 7·1. The change suffered by the percentage of imbibitional water of the soil after saturation with lime at *p*H 7·1 did not show any regularity. It was observed that the C/N ratios of the soil samples decreased as the depth of the profiles increased.

With a few exceptions, the saturation capacities of soils from Dacca, Suri, Bidar, Himayatsagar, Nagpur, Raipur, Alisagar and Guntur increase with the

increase in the depths of the profile. The profiles from Cannanore, Guntur and Comorin show the opposite behaviour. The profiles from the Nilgiri hills show a minimum saturation capacity at intermediate layers. The variations of total exchangeable bases in the profiles do not show any regularity, although there is a marked tendency for the total exchangeable bases to increase with the increase of the depth of the soil layer. In general, the ratio of exchangeable calcium to the total exchangeable bases expressed as a percentage decreases with the depth of the profile. The rate of electrodialysis increases with increase in *p*H value ; there is a slight rise with temperature up to 30°C. The variations in the ratio of Ca/N in the electrodialyzate of alkaline soils fit in with the hypothesis that the cause of infertility of such soils lies in the deficiency of available calcium.

The amounts of aluminium displaced in the supernatant liquids of hydrogen clay+salt mixtures have been estimated and correlated with the amounts of the cation of the salt adsorbed and the titratable acidity of the supernatant liquid. The amount of cation adsorbed is in fair agreement with the titratable acid. The displaced Al cannot be attributed to the solvent action of the free acid developed on the addition of the salt to the hydrogen clay. On hydrogen clays from laterite soils the amount of displaced Al increases with the concentration of the added salt becoming almost equal to the titratable acid at higher concentrations. The hydrogen clay of a black cotton soil, on the other hand, shows an increasing discrepancy between the displaced Al and the titratable acid as the concentration of salt increases. The amount of displaced Al decreases with increase in base saturation of the hydrogen clay.

A study has been made of the base-exchange capacity, the content of exchangeable bases and exchangeable hydrogen and the *p*H of the water and KCl suspensions of some Indian soils using different methods of estimation. Parker's and Schollenberger's methods give the same base-exchange capacity which is equal to the content of total exchangeable bases determined by R. William's and Schollenberger's methods in the case of two base-saturated soils having free carbonates. The exchangeable hydrogen of three acid soils estimated by Hardy and Lewis's method as also by titration with baryta in presence of normal-$BaCl_2$ has been found to fall short of the difference between the base-exchange capacity and the total exchangeable bases. The base-binding capacity of hydrogen clays obtained from different subfractions of clay of a black cotton soil increases with decreasing particle size till a diameter of 0·1 micron is reached after which it decreases. The base-binding capacity of the hydrogen clay from the finest subfraction is distinctly low. Its chemical composition is also markedly different from that of the others.

The soils of Hagari in MADRAS Province were found to give a total shrinkage coefficient of about 60 per cent by the Haines' method. Residual shrinkage commences when the moisture content comes down to about 11 per cent. Moisture equivalent for the sample from the second foot layer is found to be much higher than that for the first foot layer though the physical composition of both the layers is almost the same. On account of the heavy nature of the soil, the layer of soil 3 in.-12 in. gets very hard if the desiccation of soil moisture is rapid. But if the moisture can be maintained in the top 12 in. for a sufficiently long time till the plant has established itself, the setting in of the hardness is of no consequence to the plant growth.

Four Indian laterite and red soils have been tested at different temperatures from 110°C. to 600°C. and the loss in weight of the soils at those temperatures has been determined. The results show that all the absorbed (hygroscopic) water is not removed at 110°C. Upwards of 130°C. the loss is mainly that of organic matter and at about 250°C. almost all the organic matter is destroyed. Upwards 250°C. the loss is mainly of combined water. At 350°-400°C. the crystal lattice of colloidal complex is broken and further loss of combined water takes place. Upwards of 550°-600°C. no further loss takes place and the loss at 600°C. is equal to the ignition loss over bunsen burner. The maximum and minimum saturation capacities of Indian laterite and red soils are found to be 15 and 2·5 respectively as against 46 and 14 of a set of soils of temperate climate. For the soils with lower silica/sesquioxide ratios, i.e. the soils more leached, the *p*H is lower, the lower degree of saturation also gives low *p*H, though not in all cases.

Soil analysis

The previous work on hydrogen clays was extended during the year to clays isolated from other soils. A study was made of the base-exchange capacity, the total and individual exchangeable bases, the *p*H of water, KCl extracts and the content of exchangeable hydrogen of some Indian soils using different methods of estimation. The precipitating action of sodium ferrocyanide on the colloidal matter of some Indian soils was also studied. Under certain conditions this reagent has been found to serve as a fairly good dispersing agent in the mechanical analysis of these soils.

Parker's and Schollenberger's methods give nearly the same base-binding capacity of hydrogen soils (i.e. soils whose exchangeable bases have been replaced by H+ions) which is in fair agreement with that obtained on titration with $Ba(OH)_2$ in presence of N-$BaCl_2$ when the titration is carried out allowing sufficient time for the interaction. Hardy and Lewis's method, as also estimation of the Ba or Ca adsorbed on leaching with neutral normal solutions of $BaCl_2$, $CaCl_2$ and calcium acetate, give low results.

Mattson's method for the removal of free inorganic oxides contained in clays causes a marked decrease in the base-binding capacity of hydrogen clays obtained from a red laterite soil from Bengal and a Bhata laterite soil. A definite increase in the base-binding capacity is observed on treatment according to the method of Drosdoff and Truog. Less marked variations are caused by Tamm's method. Treatment according to all the methods causes a decrease in the percentages of SiO_2 and Fe_2O_3 in the hydrogen clay and an increase in that of Al_2O_3.

Nitrogen transformations in soil

At BANGALORE, when molasses or its solid lime compound is added to the soil, the fixation of atmospheric nitrogen continued for about 8 to 12 days to the extent of about 1 per cent on the weight of manure added, but after the above period, most of the nitrogen so fixed was again lost. The loss could, however, be considerably minimized by the addition of cellulosic materials such as straw. A moisture-content ranging from 35 to 50 per cent of the moisture-holding capacity of the soil was found to be optimum for ammonification

and nitrification. Higher moisture levels inhibit nitrification much more than ammonification, while the reverse is the case at lower moisture levels. The *ammonifiers seem to be composed of two groups—one aerobic and the other* anaerobic. The activity of the ammonifying organisms is higher under aerobic conditions. The solubilization and movement of organic forms of nitrogen in the soil have been followed and the quantities of organic forms of nitrogen brought into solution by the application of organic matter, such as rice straw, dried blood and *pongam* leaf, is greater under swamp soil conditions than in the moist soil. During such decomposition of organic matter, there is considerable movement of nitrogen from layer to layer, depending on the texture and reaction of the soil being less in saline and alkaline soils than in acid or neutral soils.

An examination of the influence of sunlight on the decomposition of nitrogenous substances, such as dried blood, ammonium sulphate, sodium nitrite and sodium nitrate added to soil and kept under sterile conditions, has proved that sunlight exerts no appreciable influence on the conversion of organic nitrogen into ammonia or the conversion of nitrite into nitrate. Solar radiation exerted a quantitative effect on the conversion of ammonia into nitrite, but this reaction is not so important as the agency of micro-organisms in bringing about nitrification. The couclusion is therefore reached that biological reactious are largely responsible for the processes of ammonification and nitrification in the soil, though nitrite is formed partly also as a result of photochemical action.

At COIMBATORE, studies on photo-nitrification showed no signs of nitrification in sterilized soils even after they were exposed to sunlight for 600 hours, while nitrification was effected in unsterilized soils whether exposed to sunlight or not.

At NEW DELHI, the effect of sunlight on the nitrification either of ammonium sulphate or of solutions of sodium nitrite were of a negative character. Dr Dhar has also shown that (*a*) when nitrogenous manures are added to the soil either in fields or in pots or in dishes, there is a considerable loss of nitrogen in the process of nitrification, (*b*) this loss is greater in soils exposed to sunlight than in those kept in dark, (*c*) the amount of nitrate formed in the soil is generally greater in the soils exposed to sunlight than in the dark ones although the temperature of the exposed and unexposed may be the same, (*d*) when the total nitrogen added to the soil is the same, the loss is greater with ammonium sulphate than in the case of oil-cake, (*e*) this loss is minimized when molasses and carbonaceous substances are added to the soil along with the nitrogenous manures.

In the PUNJAB, a study of the causes of loss of nitrogen from arable soils, with the ultimate object of endeavouring to control it, is being made and the influence of various factors, such as mechanical composition of the soil, temperature, moisture, etc., on nitrogen-content is under examination. The temperature which is optimum for nitrification process in a light soil does not hold good for a heavy one. In a sandy soil nitrogen is lost at temperatures from 40° to 50°C., but not lower, though no loss was observed in a heavy soil at any temperature. When all the different forms of nitrogen in the course of nitrification of ammonium sulphate in soil are totalled up, there has always been found a shortage to be accounted for, i.e. a difference between the total nitrogen in the

soil plus the nitrogen added for nitrification, indicating a loss of nitrogen during the process. A series of experiments were set up to ascertain if the loss occurred from the soil as elemental nitrogen. Under field conditions and in sunlight, the losses would necessarily be much higher. In one series of experiments, nitrogen losses amounting to 40 per cent of added ammonium sulphate were observed. Experiments with a large number of rice-field soils, collected from different parts of India, have shown that a considerable amount of nitrogen is fixed in some of them when they remain submerged. The agents responsible for the above fixation are certain blue-green algae. Four species of blue-green algae (three Anabaenas and one Phormidum) have been obtained in a condition completely free from bacteria and other contaminating organisms. The bacteria-free cultures have been subjected to rigorous tests. Careful experiments with these bacteria-free cultures showed clearly that the blue-green algae present fix atmospheric nitrogen. Experiments to ascertain whether any measurable amount of nitrogen is fixed in rice-field during the dry period, i.e. after harvest till next transplantation, showed that fixation of nitrogen took place in some of the soils, yet by no means can it be regarded as general as the fixation under waterlogged conditions.

A new species of *Azotobacter* (*Az. indicum*) was isolated from Dacca soil. This organism is more acid-tolerant and fixes more nitrogen than any of the species previously described.

The various ways by which nitrogen may be lost from waterlogged soils have been investigated. The nitrate formed during the dry season is rapidly assimilated by the micro-organisms when the soil is waterlogged, and there is little loss by denitrification or by leaching. A large quantity of nitrogen might be lost from waterlogged soils as a result of the anaerobic decomposition of the organic matter.

Soils of Bellary district, when grown with unirrigated crops, contain very low organic carbon content, mostly concentrated at the surface and equally low nitrogen content, the C/N ratio being in the neighbourhood of 25 in upper layers and gradually decreasing with depth. In irrigated soils, however, the C/N ratio is about 10 on the surface and increases up to 24 at the depth of 2-3 ft. In red soils of the same area, the C/N ratio is below 10 at all depths.

Under manured conditions, seasonal variations in total nitrogen are large compared with the unmanured plots. The fluctuations are generally confined to the top 6 in. layer. In a field cropped with *sorghum*, it is generally found that nitrogen attains a maximum and a minimum value twice in a year.

Soil fertility and management

The available data on crop yields resulting from different kinds of tillage and cultivation experiments were collected and these were under examination with reference to varied soil characters under varied climates. The results from several experimental stations have been classified as comparative data of crop-yields obtained with the use of inversion and no inversion ploughs; by deep and shallow ploughing; frequency of deep ploughing; seed-bed preparation by ploughing and interculture versus no interculture. The use of inversion ploughs did not, on the whole, result in increase in crop-yield, although in the very early years, in some cases, when the land was relatively

rich, inversion plough appeared to be slightly beneficial. Where the trials continued for long periods, there was clear tendency towards a decline in crop-yields by the use of inversion ploughs. The results of intercultural experiments are of a varied nature and will have to be examined in relation to soil characteristics and climatic influences.

Root studies in *setaria* and *sorghum* for different cultural treatments showed that ploughed and *bunded* plots had a root-system which was 37 per cent greater than in no-manure plots. Both cotton and *sorghum* following fallow in the previous year had double the root-system of crops following a previous crop. *Bunding* the plots accompanied by ploughing was found to be a definite advantage both from the point of view of increased yield and extra profits.

At Bijapur, the deep black soil responded very well to shallow and alternate year ploughings, to interculturing and to scooping and listing. The limy soil responded distinctly to farmyard manure and to sunn green manure. The large-scale trial of the Bombay dry farming method at this station resulted in giving 90 per cent higher yield of grain and 93 per cent higher yield of straw when compared with the yields of the local cultivators' methods.

Soil tilth formed by different ploughs is different and the yield and the moisture results are influenced by the nature of the tilth. In heavy loamy soil, draught given from the start of the dry weather lowered the water requirements of both gram and wheat, but the yields were also reduced, being more marked in the case of gram than in that of wheat.

Investigation on the associative relationship of legume and non-legume plants in common crop mixtures in the PUNJAB was continued. The combinations were *chari-guara*, wheat-gram and *senji*-oats. *Guara* suffers immensely by its association with *chari* without the latter deriving any significant benefit. Similarly, the yield of gram is lowered by its association with wheat and the latter receives no corresponding advantage. Identical results were obtained in the *senji*-oats combination. In the case of such mixtures, the yield of the leguminous crop is affected adversely, whilst the other partner in the combination derives no proportionate advantage. The experiment indicates also that this adverse effect is not the result of crowding out the leguminous plant.

Water of some of the wells in Petland Mahal is reputed for the cultivation of tobacco. The variation in the composition of the well water from the whole area is considerable. There are some wells which contain total solids as low as 50 parts per 100,000, while one well in Bhandhani contains total solids as high as 813 parts per 100,000. It has been suggested that the small amount of nitrates in these waters contributes to their reputation for tobacco cultivation. The nitrate-content of these waters calculated as potassium nitrate is found to vary from zero to 72 parts per 100,000 parts of water. Assuming that the tobacco crop requires on an average about 12 acre-inches of water during its life, the quantity of water supplied would be 272,250 gallons per acre. This would contain at the rate of 3 parts of potassium nitrate per 100,000 parts of water, 81 lb. of nitrate.

Soil reclamation and usar *soils*

The investigation has been carried out in connection with the cotton physiological research to determine the causes of the periodic partial failures of the

Punjab-American cotton crop. One of the causes responsible for the condition of *tirak* or bad opening of bolls is excess of alkali salts in the subsoil, and it has been shown that an apparent method of overcoming this trouble is to delay the date of sowing the cotton crop in such soils. The accumulation of these alkali salts in the subsoil is considered to render the water in the soil unavailable to a very great extent in the region of their concentration. This theory presupposes the movement of salts in the soil to be different in different years.

Two years' trials have shown that whilst the application of molasses at doses of 50 and 100 mds. per acre has increased the yield of wheat grain and wheat straw on alkaline soils, the increase has been very far from commensurate with the expense. It seems clear that the claims made by certain workers that molasses can be used as a reclaiming agent for alkali soils are not borne out.

Chemical and mechanical analyses of *kallar* soils on the farms at Hansi and Fatna have indicated that the new recognized treatment of growing rice, followed by berseem for green manuring should be applied to the Hansi soil, whilst, in addition to similar treatment, the Fatna soil requires an application of gypsum.

In Cochin, the concentration of salts in the water increases as the dry season advances, but even towards the end of the dry season, the concentration does not go to such an extent as to make the water unfit for use. The water can therefore be safely used throughout for irrigating the lands. The concentration of salts in the soil also increases with the advance of the dry season ; but the percentage becomes lower immediately after irrigation. As the water evaporates, the concentration also increases since the salts are left behind. The salts present in the soil of *kole* lands will not therefore do any permanent injury to the land and they can be easily leached away by letting in water or opening drains. The *chals* in *kole* lands are much silted up now, making drainage very defective. It is this defective drainage that causes salts to rise up, and unless the *chals* are deepened, the salts cannot be washed out of the soil. Effective drainage alone will remove the trouble arising from the rise of salts.

The effect of lime on the native potash of the Dacca red soil was further studied, and an experiment was laid down to find out the influence of time on the liberation or otherwise of potash by lime. Lime in a small dose has very little immediate effect, but after some time has elapsed the soluble potash begins to decrease. The higher the dose of lime, the more rapid is the decrease.

It has been found in the United Provinces that the alkalinity of the soil is due to the presence of sodium carbonate and sodium bicarbonate. In most cases the quantity of bicarbonate present is in excess of the carbonate and this accounts for a comparatively low pH value in spite of the soil showing marked sterility. The great majority of the *usar* soils in the province are in an advanced state of degeneration. Saline soils have been observed only on a small scale on the Mat Branch and upper Ganges canals. A number of fresh soil profiles were examined during the year. The results reveal the fundamental differences in the formation of the surface and subsoils, especially in relation to reactions brought about by variations in the systems of irrigation or drainage, crop or cultural conditions.

Soil erosion

The question of soil erosion is continuing to engage the attention of departments of agriculture and forestry in the different provinces, principally in the PUNJAB and BOMBAY. The Central Board of Irrigation in India considered the serious nature of the erosion problem in India and passed the following resolution on the subject: 'The Board is convinced that the evils of denudation in India are so serious and widespread that action for its further preservation should be taken without further delay. Denudation causes high floods in summer and low river levels and small supplies in winter which result in: (*a*) damage to canal systems through interference with the regularity of canal supplies; (*b*) harmful deposits of sand; (*c*) interference with river navigation; and (*d*) widespread damage to the countryside. Methods which have been found effective depend on local conditions. They include (1) better field cultivation in order to reduce erosion from ploughland; (2) better livestock management in order to reduce erosion from grazing lands; (3) afforestation of such village waste land as can be devoted to the production of timber, fuel and fodder trees; (4) conservation of grassland; and (5) the substitution of organized *taungya* for shifting cultivation.'

Beneficial effects have resulted from the working of the Punjab Chos Act passed in 1900 with a view to preventing damage due to erosion in the Siwalik Range (Hoshiarpur district) and similar legal measures in other areas.

The Government of Bombay have published draft rules for the regulation of grazing in the forest areas of the province. Much attention does not appear to have been paid to the question of erosion in the high rainfed slopes of the Malabar coast or in the high plateau regions of Mysore. In many districts, the anti-erosion campaign was carried out intensively, mainly by means of actual anti-erosion, i.e. *bunding* schemes on cultivators' lands and by the organization of district *bunding* classes. In the North-Central Division, over 10,000 acres of cultivators' lands were *bunded* scientifically and training classes of 50 cultivators each were held at three centres. In the southern Mahratta country, 11 *bunding* classes were held and the Bunding Officer prepared 25 schemes involving 738 acres for private cultivators. There were 589 students from cultivating classes who received practical instruction in modern *bunding* methods and in the preparation of anti-erosion schemes. Similar classes were held in the Gujarat division and in the South Central division where numerous applications are being received from cultivators for advice and assistance in the protection of their lands from erosion.

Soil erosion in TRAVANCORE, as in various other countries, has become a serious menace. One of the methods of preventing the fertile top soil from being washed away is to plant cover crops. It also checks weeds and preserves moisture. The majority of cover crops are leguminous, which have the power of absorbing free atmospheric nitrogen and forming nitrates in the soil. Thirty acres of rubber on the Pepper farm, Koni, that were interplanted with two kinds of cover crops during the previous year, did well during the year under review.

Physiological response to manuring

In close association with the investigations on soils and fertilizers are the studies on plant nutrition in general and in particular the effect of soil

conditions and fertilizers and manurial applications on plant metabolism and on the quality of the end products of that metabolism. The knowledge that manures and fertilizers can influence the quality of the crop is new and originated about ten years ago and necessitates a change in views on the theory and practice of manuring. From the scientific point of view, it reveals similarity in essentials of the physiological mechanism in all life and the universal nature principles of nutrition for all living beings. From the practical point of view, the new knowledge brings into relief the inter-relationship between soil, plant and animal nutrition and the necessity for research for a rational system of manuring soils and crops to the best advantage. A study on these lines has been started at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI.

The application of fertilizers has been found to increase the rate of photosynthesis of *Andorpogon Sorghum* up to a certain optimum level after which the activity shows a decline. Potassic and phosphatic fertilizers, when applied singly, were more effective than nitrogenous fertilizers in increasing photosynthetic efficiency. It is interesting to note that a balanced mixture of N, P_2O_5 and K_2O showed a lower photosynthetic level than when one or more of the nutrients were deficient. The metabolic basis for this effect and its significance from the manurial point of view require further elucidation. Application of fertilizers influences the wilting coefficient and the water-retentive force of soils. In general, fertilizers bring about an increase in the wilting coefficient and a corresponding decrease in the water-retentive force. Potassic fertilizers have the least effect and phosphatic fertilizers the most in this direction. A combination of phosphatic and nitrogenous fertilizers form the best treatment so far as the water relations of plants are concerned. Similar results have been obtained in experiments with sugarcane in specially devised auto-irrigators. Complete manurial dose (organic or inorganic) applied at planting made the plants more economical in the use of water than if applied in two separate doses, e.g. half at planting, and the remaining half at earthing. Slow-acting concentrated organic manures such as castor-cake economized water better than artificials such as Nicifos II.

Development studies of the *jowar* plant were carried out at Sholapur and Bijapur to test the seasonal effects on growth. At Sholapur, growth in terms of height, number of green leaves and dry matter was lower than in good season. At Bijapur, these were much higher in the deep black soil but lower in the limy soil.

At Padegaon, studies in the periodical distribution of nitrogenous top-dressings which have been concluded after three years' replicated trials have proved that under judicious irrigations (95 in.) the problem of distribution is not important in normal manuring (225 lb. N) as there would be very little leaching of nitrates without at the same time increasing the concentration of nutrients in the soil solution so as to affect adversely the development of the crop which is observed in the case of heavy manuring. Detailed bio-chemical investigation in nutrition has shown that once the soil reaches its level of available phosphate, additional dose of superphosphate does not show any improvement either in tonnage or maturity. The delay in maturity in increasing nitrogenous top-dressings is found to be due to the high nitrogen and low phosphate and potash content in the cane juice. Investigation into the process

of earthing has definitely proved that the prevalent idea about the acceleration of growth and increased out-turn by pruning roots with timely earthing is not correct. What is required is the timely manuring and the system of delaying it in the case of a dearth of labour for earthing should be definitely discouraged.

Composts

A study of the various factors influencing the efficiency of the hot-fermentation process of composting showed that (1) an optimum proportion of the organic and inorganic fractions of street sweepings and of night-soil is necessary for the effective and rapid fermentation of the compost heap, (2) the addition of moderate amounts of the soil fraction of street sweepings helps to secure a great conservation of organic matter and of nitrogen and improves the quality of manure obtained, (3) an optimum moisture content of about 50 per cent should be maintained, (4) the temperature rapidly rises to 60-65°C. in two or three days after which it slowly falls and at the end of five or six days is about 50°C., (5) greater losses of nitrogen occur if the period of preliminary aerobic fermentation is prolonged beyond a week, (6) the addition of chemicals has no beneficial effect on the course of decomposition, and (7) the greatest conservation of nitrogen is secured by conducting the hot-fermentation in brick-lined and plastered trenches. A comparison of the different methods of composting town refuse (wholly aerobic, wholly anaerobic and the hot-fermentation method) showed that the greatest loss of carbon and nitrogen occurred under wholly aerobic conditions and the greatest conservation under wholly anaerobic conditions, so that the hot-fermentation method was a *via media* between the other two methods. Semi-large-scale experiments on the composting of town refuse, using either night-soil or cattle urine and dung as starters, confirmed the superiority of the hot-fermented compost to the aerobically prepared one, especially when the hot-fermentation was conducted in brick-lined and plastered trenches. Economics of the systems of composting night-soil and of poudrette manufacture were compared and the conclusion arrived at was that it would be economically advantageous for a municipality to concentrate on the preparation of wood-ash poudrette to the limit of available household ash and to divert the remaining portion of night-soil for composting.

Pot and plot experiments carried out on crops such as barley, beans, tomatoes, lucerne, *ragi* and *jowar* showed that composts exerted highly significant manurial effects as measured by increase of crop yields. The increases obtained by hot-fermented manure were significantly higher than those obtained by the aerobically prepared manure and the crop response of manure prepared purely by the anaerobic method was found to be poor.

Green manures

The relative manurial values of *guara* (*Cyamopsis psoralioides*), *jantar* (*Sesbania aegyptiaca*) and *arhar* (*Cajanus indicus*) as green manures have been compared at Lyallpur. *Guara* was found to be superior to others, since it fixed more nitrogen from the air and nitrified more readily in the soil.

Experiments on oats carried out at PUSA showed that among different species of *Crotalaria*, *C. Muijussi* was the best. Sunn-hemp, *dhaincha*, *guar*,

cowpeas, velvet bean and *meth* were better legumes for green manuring than soybean. The first four stand almost on the same level. *Urid* as green manure was inferior to sunn-hemp. There was no difference between green manuring with sunn-hemp six weeks old or of ten weeks old. Green manure in conjunction with superphosphate (at ¾ md. super per acre) gave the best out-turn of oats. Prior fermentation of sunn-hemp before its application to land increased its manurial value.

A comparison of cowpea, sunn-hemp and *dhaincha* applied at 34·3 md. of dry matter per acre to the rice crop at Suri Farm (BENGAL) showed that cowpea and sunn-hemp gave much better yields than *dhaincha*. Cowpea surpassed sunn-hemp. Investigations on the most suitable leguminous catch crop shows that none of the catch crops tried (gram, peas and *khesari*) has any deleterious effect on the growth of the subsequent paddy crop and that these crops when grown will therefore bring an extra return to the cultivator.

Irrespective of the other manures that are applied or the nature of the land, the application of green manure is a most useful practice and is of definite benefit to the paddy crop in MYSORE.

The green manurial experiments and the best age for inversion of *sanai* (*Crotalaria juncea*) gave an abnormally higher age this year, i.e. 75-90 days as against 50-60 days of the previous year. This was due to the excessive rainfall received by this *sanai* during the 1936 monsoon which gave a setback to this crop resulting in the normal growth of 50-60 days of other years being attained this year in 75-90 days. As regards the manurial value of different portions of *sanai*, whole *sanai* and above-ground portions gave the best results. In an experiment on the economics of fibre extraction from *sanai* stems and utilization of tops and roots for green manuring it appears that the highest net profits accrued from green manuring 75 days' *sanai* tops and roots followed by 90 days' tops and roots, the stems in both cases being used for fibre extraction. Tests on the manurial value of different portions of *sanai* (*Crotalaria juncea*) show whole *sanai* to be the best with regard to the nitrogen content, ammonia accumulation, humus content, C/N ratio and the yield of sugarcane. The sucrose percentage and purity coefficient in most cases were higher and glucose percentage lower on untreated plots. In another experiment to assess the manurial value of different portions of *sanai* at different ages, 50, 60 and 75 days' whole *sanai* were found to be the best. In almost all cases, percentage sucrose and purity coefficient was higher and glucose percentage lower on untreated plots. After *sanai* inversion (tops and whole *sanai*) nitrogen in the soil goes on increasing, reaching a peak in February-March, followed soon by a sharp decline, then a steady level till July and a marked decline in August. The nitrates are maximum in December-January, followed by a decline. As regards the nitrogen and nitrates put in the soil, whole *sanai* inversion proved the best. Green manuring of *sanai*, however, tended generally as usual to lower the purity and sucrose content as compared to untreated plots.

Molasses as manure

Instead of applying molasses directly to land, a much better manurial result could be obtained by a preliminary conversion of molasses either into the

calcium salts of organic acids by a process of anaerobic fermentation or into a dry lime compound by direct treatment with lime. Further observations have shown that the preliminary stage of nitrogen fixation extending over the first 8 to 12 days is followed by a subsequent period during which a considerable loss of the biologically fixed nitrogen takes place. This would explain the poor manurial response sometimes reported with molasses under field conditions. Loss of nitrogen could be minimized considerably by the addition of cellulosic materials such as straw to soil, along with the molasses-lime product. A fermentation process wherein molasses is converted into a mixture of yeast and organic acids possesses considerable manurial value. A mixture of equal parts of molasses and press-mud yield about 40 per cent of their weight of manure, containing about 1·5 per cent of nitrogen.

The direct application of molasses to crops may prove highly injurious even to legumes, such as berseem. At Lyallpur, the application of molasses caused a reddening of the leaves, arrest of growth and poor yields. Since berseem is a legume, the harmful effect of molasses cannot be due solely to the binding up of soil nitrogen, but probably to other factors as well, such as the presence of an injurious component in molasses.

In MYSORE, while molasses, under certain conditions, could be used with advantage as a soil corrective, it was scarcely a good manure. While molasses had no beneficial effect on the immediate crop in good soils, it did influence advantageously the yield of the next crop.

At Shahjahanpur, molasses continued to give favourable results for the third year, but is considered uneconomic at present rates and over-head cartage. It is interesting that the application of molasses had no effect on the juice quality while castor-cake and ammonium sulphate had an adverse effect, particularly the latter.

Manuring of rice

Field experiments carried out in BIHAR have shown the advisability, under Gaya conditions, of giving equal doses of both nitrogen and phosphorus to the rice crop. The best results were obtained with the maximum dose tried, viz. 60 lb. N plus 60 lb. P_2O_5 per acre, which brought in a net profit of Rs. 35 to 40 per acre. Application of green manure (*dhaincha*) more than doubled the yield, giving a net profit of Rs. 15 to 20 per acre.

Manurial trials conducted in the CENTRAL PROVINCES during the last three years have shown that the application of P_2O_5 at 20 lb. per acre in the form of superphosphate was most economical and gave the largest net profit of Rs. 3-12 per acre. A net profit of Rs. 2-14 per acre was obtained by 20 lb. P_2O_5 with 20 lb. N in the form of ammonium sulphate.

Experience in ORISSA has been that though the application of ammonium sulphate at 20 lb.-40 lb. N per acre gave increased yields, the increases did not pay the cost of manure applied.

Potash and lime did not show any response in the UNITED PROVINCES. Similar has been the experience at DACCA; in addition, magnesium also failed to show any beneficial effect. A mixture of lime and bone, however, to the extent of a 6 md. each per acre, proved to be quite beneficial on the red laterite soil of Dacca.

A comparison of safflower-cake and castor-cake as manure for the rice crop, carried out in the BOMBAY Province during the last three years, showed that on an equal nitrogen basis, castor-cake was superior to safflower-cake.

In ASSAM, no residual effect of cowdung was observed for 100 md. and 200 md. applications. Cowdung at the rate of 300 md. per acre gave an appreciable and significant increase over all other treatments. The slight increases obtained with 2 md. and 4 md. Alphos per acre over control are not at all significant. Similar results were obtained last year which confirms that this particular phosphatic manure has no effect on paddy.

In Assam investigations into the losses of valuable plant food through leaching from different types of rice soils showed that :—(*a*) Owing to the heavier nature of the soil, quantities of the leachates obtained after different periods are strikingly lower in the case of *dorsa* soil than those obtained from the light *matasi* soil. (*b*) The composition of the soil which was either untreated or treated with moderate doses of fertilizers was not appreciably altered as a result of leaching. (*c*) In both the soils there was a progressive increase in the amount of total solids lost as the period of leaching increased. Most of the nitrate nitrogen from the *matasi* soil was washed out in the first 24 hours, whereas there was a progressive increase in the amount of nitrate nitrogen lost from the *dorsa* soil as the period of leaching increased. Quantities of most of the constituents lost by leaching from the *dorsa* soil were strikingly lower than those lost from the *matasi* soil.

The application of ammonium sulphate to broadcast late paddies at the time of beshuaning and a week before flowering has been found to be beneficial. Increasing doses of this fertilizer (20 lb. N per acre to 40 lb. N per acre) have given increased yields, but these do not pay for the cost of manure. The effect of potash and lime was tried but negative results were obtained. The effect of ammonium sulphate (60 lb. N) was pronounced and was still more so when this quantity was applied in two or three doses as against a single dose. Green manuring with *sanai* (sunn-hemp) of nine or seven weeks' growth was more effective than *sanai* of five weeks' growth, and all the three treatments superior to no treatment. Molasses, applied either at the rate of 100 or 200 md. per acre, gave a substantial increase in yield, but the time of application did not appear to matter much except in so far as an application just before transplantation was likely to damage the crop. Paris green applied to kill mosquito larvae in the fields did not affect the rice yield. Research on water requirements of the rice plant at various stages of its growth had been conducted with a view to finding out the critical stages, if any, in the life-cycle of the plant. It has been observed that soil moisture below 33 per cent soil-saturation capacity considerably reduced the yield and that the addition of phosphate to the soil minimized the water requirements.

Manuring of sugarcane

The results of the competition sponsored by Marsland Price & Co., Ltd., at the instance of Mr Walchand Hirachand of Bombay, offering a prize of Rs. 1,000 for growing 100 tons or more of sugarcane per acre, has revealed some interesting facts. Out of 21 competitors who entered the competition, 14 finally offered their fields for harvesting and three of these from the Bombay

Province showed a tonnage of over 100 tons. In addition to thorough and deep preliminary cultivation of the land, heavy manuring was resorted to in these cases, consisting of 30 cartloads of farmyard manure, 4 tons of oil-cake, and 4 bags of ammonium sulphate per acre, in addition to green manuring and sheep folding. The expenses for manuring came to about Rs. 350 to 400 per acre and including other items of cultivation, the total expenses came to about Rs. 750 per acre or Rs. 7 per ton of cane.

Experiments carried out at Kopergaon farm (BOMBAY) with EK 28 variety showed that the cane responded to applications of 150 and 200 lb. N per acre to a satisfactory extent. Including the yield of ratoon cane the yields for 150 lb. and 200 lb. N were 61,000 and 78,700 lb. of cane. The application of 100 lb. P_2O_5 in the form of superphosphate gave an extra yield of about 800 lb. of *gul* and was a paying proposition. Experiments conducted at Padegaon, Bombay province, have indicated the optimum dose of nitrogen to be very much higher than what is adopted in practice. Similar experiments laid out in the Irwin Canal farm have given almost the same results as at Padegaon.

In ASSAM, the effect of green manures (cowpea), both with and without a phosphatic dressing, was significant over control in both the experiments with Co 290 and POJ 2714. The average increase due to green manures came to about 3·5 tons stripped cane per acre over control. The phosphatic dressing had little effect in showing an increase in the yield of the cane crop both on the green-manured and non-green-manured plots.

In the PUNJAB, the five years' results of manurial experiments have definitely indicated that it is more economical to apply half the usual heavy dressing of farmyard manure and to substitute the other half by artificial fertilizers or other quick-acting organic manures as *toria*-cake.

At Shahjahanpur (UNITED PROVINCES), the complete nutrient experiment on the interaction of nitrogen, potash and phosphates again gave for the third year remarkable responses to nitrogen application, but practically none to potash or phosphate applications, thus confirming the general deficiency, so far, of only nitrogen in these soils. The most economic dose of N revealed by this experiment was 100 lb. per acre, higher doses having an adverse effect on quality and a pronounced delaying effect on maturity.

The N, P and K experiment has again indicated for the fourth year in succession that it is nitrogen alone which has a significant effect on the yield of cane, thus indicating sufficiency of potash or phosphates in our soils. In a test of organic and inorganic manures, best yields have been given by molasses followed by departmental mixture No. II, castor-cake and ammonium sulphate. The green manurial experiment showed that inversion of 50 days whole *sanai* was the best followed by 75 days whole *sanai*. A four-factor experiment revealed during the first year that Co 331 and Co 312 were both similar to one another but superior to Co 385; that castor-cake and ammonium sulphate were superior to farmyard manure and that N at 200 lb. was the best, followed by 100 lb. N. In an intensive cultivation yield test autumn sowings have proved definitely superior to spring sowings, but no effect of the time of sowing was seen on the maturity of cane. In a comparative study of various organic and inorganic manures on sugarcane, the nitrogen content of the soil was found in the order: calcium cyanamide; farmyard manure; departmental mixture No. II; factory press-mud; ammonium sulphate; factory molasses;

castor-cake; municipal compost; farm compost; and no manure. The nitrate accumulation was, however, in the following order; departmental mixture No. II; farm compost; castor-cake; calcium cyanamide; farmyard manure; ammonium sulphate; municipal compost; no manure; factory press-mud and factory molasses. No appreciable difference was observed between the organic and inorganic manured plots with respect to sucrose percentage in juice and purity coefficient. The control plots gave highest sucrose percentage and purity coefficient as expected in most cases. The yield was best in factory molasses followed by departmental mixture No. II, castor-cake, ammonium sulphate, calcium cyanamide, factory press-mud, farm compost, municipal compost, farmyard manure and no manure.

In COCHIN, the substitution of ammonium sulphate for part of the cake gives a greater yield. It therefore appears that it is better to supply nitrogen to the sugarcane crop in the form of a mixture of ammonium sulphate and cake than in the form of cake alone.

Manuring of cotton

The usefulness of the application of artificials on cotton is no doubt conditioned by the prevailing price of cotton. The application of 25 lb. N as ammonium sulphate (in the Bombay Province) raised the yield of seed cotton from 587 to 681 lb. per acre, a difference which did not cover the prevailing cost of the manure.

At the Surat Agricultural Station, however, where the no-manure plots yielded only 218 lb. of cotton, the application of 10,000 lb. of farmyard manure once in six years yielded 78 per cent higher yield and increased the net profit by Rs. 17 per acre. This was equivalent to the application of 20 lb. nitrogen in the form of ammonium sulphate at sowing. The application of ammonium sulphate after stand was distinctly superior to the application at sowing. Thus 20 lb. of nitrogen applied after stand yielded 104 per cent increase in yield as compared to 68 per cent increase when applied at sowing.

Manuring of wheat

The combined rotational and manurial experiments were continued at PUSA. With the harvest of the year under report, the results of eight years' experiments are available. In unmanured plots the yield of maize after a crop of peas was nearly twice the yield of maize following a crop of pigeon-pea (*Cajanus indicus*), the yields being 744 lb. and 444 lb. respectively. Maize after wheat yielded 644 lb. The effect of the addition of a mixture of fertilizers (20 lb. N as ammonium sulphate, 40 lb. P_2O_5 as superphosphate and 25 lb. K_2O as potassium sulphate) was not equivalent to that of 4,000 lb. of farmyard manure. The yields of wheat following maize were better than those of barley, peas or pigeon-pea after maize. An application of 20 lb. of nitrogen as ammonium sulphate had no effect on wheat following maize, but applications of either rape-cake or a mixture of nitrogen and phosphate brought up the yield to the level of that obtained with 4,000 lb. of farmyard manure. Four thousand pounds of farmyard manure gave a yield nearly double that from an unmanured plot. Eight thousand pounds of farmyard manure did not give a yield double that with 4,000 lb. Forty pounds nitrogen as ammonium

sulphate showed no appreciable increase in yield over the unmanured plots, but when combined with superphosphate the yields were considerably improved.

Field trials carried out in the CENTRAL PROVINCES showed that the yield of wheat per acre was raised from 542 lb. to 679 lb. per acre by the application of ammonium sulphate at 15 lb. N per acre. A study of the economics of the application of the two manures showed that the use of Nicifos II yielded a small profit of Rs. 1-6 per acre over the cost of the manure, while the use of ammonium sulphate failed to recoup the cost of the manure. Applications of Nicifos II at the rate of 20 lb. and 30 lb. N per acre gave significantly higher yields, but the increased yields did not pay the extra cost of the fertilizer.

Manuring of tea

The important points in the manuring of tea are the maintenance of the soil reaction on the acid side, say near *p*H 5·0 and the supply of available nitrogen to the crop. Poor, unmanured lands yield about 400-500 lb. tea per acre and the yield can be increased by 6-8 lb. for every pound of available nitrogen added in some suitable form, preferably as ammonium sulphate. The increase in crop obtained is proportional to the nitrogen applied, up to high limits, say about 80-100 lb. of nitrogen per acre. Usually, it pays to apply 200-300 lb. of ammonium sulphate per acre. Since tea is a commercial crop and fetches a good price, it pays well to manure it. The unit cost of nitrogen is lowest in the case of ammonium sulphate and calcium cyanamide (about Rs. 6-8), is higher with nitrate of soda (9-8) and still higher in the case of oil-cakes (11-6 to 15-0), horn-meal (14-7), dried blood (17-9), fish guano (22-4) and animal meal (23-7). Since in the usual practice of tea cultivation, prunings and other tea estate wastes, amounting to about 3 to 4 tons per acre of green material, are returned to the soil annually, further additions of bulky organic manures such as composts or farmyard manure do not give such good response as artificials. In fact, Cooper finds that from the point of view of nitrogen efficiency, the addition of uncomposted materials (along with the nitrogenous starter used for composting) is even superior to adding composts, since the loss of nitrogen occurring during the process of composting is thereby avoided. There is little or no difference in quality of second flush teas when applying artificial manures at the rate of 60 lb. of nitrogen combined with 30 lb. of potash and phosphoric acid respectively, whether these manures are supplied in the autumn or in the spring. The practice of applying cattle manure at the time of replanting is one which is strongly recommended; 10 lb. of well-rotted manure, mixed with the soil which is filled in round the plant, has been found to have markedly good effect on plants put out on worn-out soils. This good effect is ascribed to a great extent to the resulting improved physical condition of the soil encouraging the spread of the roots of the young plant. Organic auxiliary food factors are also probably of some value to young tea. Good well-rotted compost probably has a similar effect. It appears that the *p*H value of soils can be appreciably altered either towards acidity or alkalinity if extremely heavy applications of acid or alkaline manures are made. This is of the greatest importance in nurseries since the growth, health and vigour of young tea plants are largely determined by the soil reaction.

Fertilizers

Exports of manures, other than oil-cakes and saltpetre, declined appreciably from 89,000 tons valued at Rs. 69 lakhs in 1937-38 to 53,000 tons valued at Rs. 37 lakhs in the year under review. Despatches of manurial bones including bonemeal which represented 76 per cent of the total quantity exported in 1938-39 fell by 29,000 tons or 42 per cent to 40,000 tons (Rs. 27 lakhs). Belgium, Ceylon and the United Kingdom curtailed their requirements from 35,000 tons, 15,000 tons and 12,000 tons to 15,000 tons, 12,000 tons and 8,000 tons respectively; while there were no shipments to the United States of America, her offtake in the preceding year being 3,000 tons. Exports of other manures also declined, both in volume and in value, as compared with 1937-38.

The preliminary experiment with granular calcium cyanamide compared to organic manures on sugarcane gave satisfactory results. Although organic manure was found to be significantly superior to calcium cyanamide, the latter gave highly significant increase over control. Unlike other artificial fertilizers, it had no deteriorating effect on the quality of juice.

The result of the pineapple complex manurial and cultural experiment shows that potash and phosphate when added singly act injuriously on the yield of the plants. The plants in the furrows failed completely owing to waterlogging and those on the ridges gave as high as 60·6 per cent of fruiting.

The adverse effect of quick-acting manures like ammonium sulphate on germination appears to decrease with increase of moisture in the soil, becoming negligible under wet planted conditions. Earthing up in cane varieties like Co 312, which have a tendency to lodge, appears to improve the yield as well as quality. Irrigation during or before frost saves the crop from injurious effects, while smoking did not appear to have any appreciable effect. The application of potash and nitrogen without a basal dressing of cattle manure has given significantly increased yields of groundnuts. The beneficial effect of a basal dressing of three tons of cattle manure hy itself just misses statistical significance. Oil analysis and qualitative determinations do not reveal any effect by the treatments.

2. Agricultural meteorology

Proposals for making the Agricultural Meteorology Section permanent were under consideration by the Government of India. In the meantime the Imperial Council of Agricultural Research continued to finance the section as in previous years.

The instrumental equipment as well as the grounds of the Central Agricultural Meteorological Observatory were extended during the year. Besides serving as the centre for experimental investigations, the observatory continued to be a training ground for agricultural workers. The section maintained its liaison and research activities and devoted considerable attention to the practical aspects of the subject, as in previous years.

Experimental or biological

The extension of the grounds of the observatory provided a great impetus for enlarging the scope of the experimental work undertaken at the observa-

tory in many ways. About the end of the year arrangements were made to erect a tower 30 feet high at the centre of the new plot. The construction of the tower was completed and with its help investigations on the variations with height of a number of meteorological factors were extended up to a height of 35 feet. A series of anemometers at heights of 2 ft., 6 ft., 12 ft., 20 ft., and 35 ft., thermographs and hygrographs housed in special Stevenson screens at heights of 1 ft., 4 ft., 15 ft., and 30 ft., and a rain-gauge at the top of the tower were set up. The micro-climatic observations in the open at the maximum and the minimum temperature epochs were extended up to 35 ft. above ground. This vertical range practically covers the height up to which the interaction between the plant-world and the air layers near the ground may be expected to extend. To study the rate of ascent of moisture through typical soils and the rate of evaporation from their surfaces, two more sets of soil evaporimeters were made and set up on the new plot.

Amongst the new instruments useful for investigations in agricultural meteorology, designed or made during the year under review, may be mentioned a simple instrument designed to study the fate of rain or irrigation water arriving at the surface of the soil. The instrument is expected to provide a simple and direct method of estimating what fraction of the water supplied to the soil surface, whether as rainfall or as irrigation, is lost by evaporation and by percolation through different depths of the soil and what fraction is actually retained by the soil layer under consideration. Preliminary trials with working models of the instrument are in progress. The frost-alarm apparatus, to which a reference was made in the last year's review, has now been constructed by the Laboratory Apparatus Works, Karve Road, Poona, and after a series of trials has been found to be quite satisfactory. These instruments of local make can now be obtained from the above firm at a reasonable price.

Experiments on the movement of moisture and heat in the air and soil layers near the ground, studies of the microclimates of crops, the intensity of solar and sky radiation and the thermal balance at the surface of the ground, evaporation and transpiration, exchange of moisture between plant materials and the atmosphere, and the seasonal variation of the nitrogen content of the surface layers of the soil were continued.

The Central Agricultural Meteorological Observatory provides opportunities for the study of borderland problems in plant physiology, e.g. transpiration, nitrogen fixation, etc. which require for their proper understanding a comprehensive scheme of related meteorological observations.

Statistical section

On the statistical side, special attention was paid to the work on 'precision' observations designed to reveal the effect of weather on crops at Poona and Karjat and some experience was also gained in applying the methods of sampling to the estimation of the yields of crops. Much of this work was done with the cooperation of the local agricultural officers. Progress was also made with certain statistical investigations on more general subjects, which yet have a bearing on agricultural problems, e.g. (1) the date and type of onset of the south-west monsoon along the west coast of peninsular India,

(2) the secular variation in the frequency of frosts in Gujarat, (3) the seasonal distribution of rainfall in the Bijapur district and (4) evidence for the influence of afforestation on climate in the Singhbhum district. Items (2) and (3) above were taken up at the instance of the Government of Bombay, the former to see if cold waves are becoming more frequent in Gujarat and the latter to indicate the permanent measures that may be taken to minimize the effects of famine in Bijapur.

General

The section continued to act as a liaison section between meteorology and agriculture by helping agricultural workers to set up farm observatories, by training agricultural assistants deputed to Poona and by calibrating meteorological instruments sent by agricultural departments to Poona. Special attention was also paid to the meteorological problems of the officers in-charge of the locust, dry-farming, sugarcane and cereal rust research schemes of the Imperial Council of Agricultural Research.

As a result of the growing interest taken by departments of agriculture in the different provinces and Indian states, new observatories have come into existence at a large number of experimental farms. The agricultural meteorology section has rendered all possible cooperation in this growth of farm observatories. It is gratifying to note the rapid progress being made in the installation of meteorological instruments in many of the provinces and Indian states. Before long it appears that practically all the stations will have improved their equipment of meteorological instruments.

Another aspect of the liaison work is to find out what type of weather forecasts and warnings would be most useful to the farmer at large and to arrange for the issue of these warnings and forecasts by the all-India weather forecasting section at Poona. The issue of cold wave warnings to the provinces and Indian states liable to their incidence was continued by the forecasting section at Poona. The experimental scheme of issuing warnings for cold waves and heavy rainfall to district officers in the Bombay province was revised in the light of the first two years' experience. These warnings were found generally to be useful. The issue of these warnings directly to the Mamlatdars in order to quicken the process of dissemination is in contemplation. Requests for similar warnings are beginning to be received from other provinces and Indian states, and an entirely new development is taking place with regard to this work for the benefit of the farmer at large.

The agricultural meteorologist attended the meetings of the Standing Committee on Field Experiments of the Imperial Council of Agricultural Research in November 1938. The Indian Science Congress at Lahore in January 1939 afforded him further opportunities to come in contact with the leading agricultural workers of the country. The honorary research students continued to play their part in the work and programme of the section by working on borderland problems. The staff of the Agricultural College at Poona continued to extend their valuable cooperation to the agricultural meteorologist. A number of agricultural research workers and students of the agricultural college received training at the Central Agricultural Meteorological Observatory.

The discussion of important results in the form of original papers was continued. The total number of papers published during the period 1932-39 is

75, *including* about 15 in the year under review. The exchange of publications with well-known workers in India and in foreign countries was continued as in past years.

Two research students worked under the agricultural meteorologist on borderland problems. The Bombay University has under consideration the question of recognizing agricultural meteorology as a subject for the M.Sc. degree in agriculture.

3. Plant-breeding and genetics

Information of a general nature on plant-breeding in various crops is given in Chapter II dealing with ' Economic Work on Crops '. Only points of general interest are reviewed here.

Cotton

At the INSTITUTE OF PLANT INDUSTRY, INDORE, the work on genetic variability in intraspecific crosses was continued with four F_2 populations and the assumption that the value of an F_2 for selection in plant-breeding is proportional to its mean and genetic variance was confirmed.

Genetic analysis of anthocyanin has brought out the presence of a new gene in the allelomorphic series in one of the Madras cottons Telepatty which has no pigment in the plant body except a petal spot. The study of the inter-relation and linkage values of the several lintless genes in Asiatic cottons has revealed the rather complicated nature of the genetics of 1027 lintless gene. The sterility of the mutation in the Million Dollar has been shown to be due to partial asynapsis at meiosis and the inheritance of this gene is independent of those for anthocyanin and petal colour.

Twenty-one interspecific hybrids between species with 13 and 26 chromosomes were studied cytologically and found to contain $2n=39$ chromosomes except two which had 52 and 65 chromosomes respectively. These two exceptional plants had obviously resulted from chromosome doubling of one of the parents. Experiments to produce fertile amphidiploids from these sterile hybrids were in progress.

Several mutations involving anthocyanin pigment, ginning percentage and node number were obtained from X-ray treated seeds. Mutations involving lint-length, however, were not obtained. This useful work is being continued.

In MADRAS, by resorting to multiple and back-crossing, it has been possible to isolate single plants of Cambodia with long lint-length and high ginning percentage. This work promises to produce high-yielding strains of Cambodia with long lint-length and high ginning percentage.

Breeding work for evolving strains of Co 2, resistant to stem weevil, has resulted in the isolation of some strains from hybrids between Co 2 (susceptible) × South-American types (resistant), which have consistently shown resistance to the pest. It now remains to induce the yield of Co 2 into these strains.

A study of the wild cottons with regard to their resistance to insect attack has shown that *G. trilobum* and *G. armourianum* are highly resistant to bollworms and *G. contextum* to black scales. These species will be used for breeding insect-resistant strains.

Interspecific hybrids were studied cytologically. Attempts to induce chromosome doubling in them proved unsuccessful so far.

In BOMBAY, breeding for wilt-resistance was continued. Nine promising segregates from the cross between BD 8, a resistant strain, and other strains, together with their back-crosses were tested in wilt-infested and wilt-free soils, and the test indicated that all the segregates were highly resistant to wilt attack and some of them, in addition, had high ginning percentage and superior fibre-length. The F_1 of the cross between Jarila × NR 5 was also crossed with New Million Dollar—a wilt-immune strain—with a view to getting a wilt-resistant strain of Jarila with a high ginning percentage.

The work on interspecific hybrids in cotton was continued at SURAT, the object being to obtain fully fertile hybrids between Asiatic and American cottons, combining the useful agronomic characters of both, particularly the good staple-length of the American and hardiness and adaptability to Indian climate of the Asiatic cottons. Back-crossing these hybrids to their parents resulted in 15 plants more or less fertile ; one plant obtained from back-crossing *G. hirsutum* × *G. arborium* to Co 2 (*G. hirsutum*) was fully fertile. Further large scale back-crossing and treatment with colchicine and acenaphthene of these hybrids are in progress with a view to obtaining fertile amphidiploids from them.

In the CENTRAL PROVINCES AND BERAR, four new strains of *G. indicum* were under field trial. Besides being wilt-resistant, they possessed fine and long lint with the best spinning quality obtainable in Indian cottons.

In the PUNJAB, the newly developed strains of Jubilee cotton are receiving further attention with regard to the improvement of their yields. Efforts are also being made to improve the fineness of the lint of Jubilee by crossing it with *G. anomalum*, a Nigerian wild cotton possessing exceptionally fine lint.

In MYSORE, the important item of work continued to be the breeding of suitable types of cotton resistant to 'Red-leaf' disease which stands in the way of the expansion of this crop in the Irwin canal area. Crosses between MA 11 (a resistant strain) and other economic varieties were under trial. Several composite intervarietal and interspecific crosses were also under study with a view to evolving suitable strains with resistance to 'Red-leaf'. X-rayed plants of Co 2 in their fourth generation were found to be decidedly superior to the controls in point of lint-length and ginning percentage. Four more varieties were treated with X-rays during the year with a view to producing mutations in them.

Wheat

Breeding work for rust resistance was continued by the Imperial Economic Botanist at the sub-station in SIMLA with the cooperation of Prof. K. C. Mehta. During the year, F_4 populations of nine crosses were grown after testing the seedlings for rust-resistance. Out of 2,640 seedlings tested, 1,702 proved resistant. Further single plants were selected on the basis of rust-resistance and other desirable characters. The study of several F_1s of crosses, including some interspecific and intergeneric crosses, with regard to their reaction to a mixture of all the Indian physiologic races of black rust has shown suscep-

tibility to be dominant in all cases. Rust-resistance tests conducted with a large collection of foreign and indigenous wheats have revealed a promising degree of resistance to black rust in some *vulgare* wheats from Kenya. At DELHI, experiments were conducted to test the resistance or susceptibility of a large number of wheat varieties to flag and loose smuts as an essential preliminary to breeding smut-resistant varieties. Selection of non-shedding strains from inbred progenies of IP 114 and IP 120 was in progress.

In the UNITED PROVINCES, selection of desirable plants in the progeny of X-rayed seeds of C 13 was continued.

In the CENTRAL PROVINCES, further progress was made in the evolution of rust-resistant strains; Nos. 76, 267 and 281 reached their final stage of trial at which they can be safely recommended to replace the standard rust-resistant variety, A 115.

In the PUNJAB, among the new crosses C 230 has outyielded the premier wheat C 591 under field conditions throughout the province. Its grain quality, however, does not compare well with that of C 591.

Rice

In MADRAS, the hybrid strains evolved for *piricularia* resistance were again under district trials. These strains, which do remarkably well in years when the disease is present, did not show themselves superior to the local, as there was no disease in the centres of trial this year. The two hybrid strains (Co 3 × Burma) have again proved their suitability to areas somewhat liable to submersion. Four non-lodging strains with dwarf-habit, selected from X-rayed progenies of GEB 24, were again tried against the control under different levels of nitrogen. While all the strains lodged badly under conditions of heavy manuring, two of them gave slightly increased yields of grain compared to the control and very significant increases of straw. Further work for the isolation of non-lodging and high-yielding strains under conditions of heavy manuring is in progress.

Further evidence of the spontaneous occurrence of polyploidy was obtained; two triploids were isolated and studied. A tetraploid plant, with large-sized grains, arising from heat treatment of seed, was found to breed true in spite of considerable multivalent formation at meiosis. This is probably due to the elimination of gametes having chromosomes more or less than the diploid number. The sterility of a plant occurring in one of the progenies of an inter-varietal cross has been shown to be due to asynapsis. About 36 mutational types arising from X-rayed seeds of GEB 24 and Co 4 have been fixed. Besides, 16 lethal mutations involving chlorophyll deficiencies are being maintained in a heterozygous condition.

In the UNITED PROVINCES (Nagina), a number of cross progenies in different generations were under study, with the object of improving the yield and quality of varieties of different durations. The *sâthi* crosses made with a view to the evolution of high-yielding strains with the enclosed sheath character of the former were in the F_9 generation and yielded promising material for selection. To combine aroma with heavy yield, crosses have been made between T 3 (aromatic type) and suitable high-yielding types.

In the CENTRAL PROVINCES AND BERAR, genetical studies of a number of characters were in progress. In the F_1s of crosses between Blue Rose, with

'abdominal white' endosperm, and rices with translucent endosperm, the hybrid plants showed segregation of 'abdominal white' and 'translucent' endosperms in the ratio of 1 : 1. Scent in rice was found to be dominant in the F_1 generation, a finding which is in agreement with that obtained in Madras. Erect habit of plant was found to be a monogenic recessive to spreading habit. Extensive studies of the inheritance of grain-size and shape were also in progress.

In BENGAL, elaborate correlation studies between yield and several measurable morphological characters both within a strain and between strains for *aus* and *aman* paddies were in progress. Within a strain of *aus* paddy, the yield of grain was significantly associated with weight of straw, number of tillers and height of plant; but between strains weight of straw and number of tillers only were significantly associated with grain yield. For a given strain of *aman* paddy as many as nine characters were significantly associated with grain yield, but, between species, number of tillers, weight of straw and flag-breadth were the only characters which were significantly associated with yield.

In ASSAM, the inheritance of grain size was worked out for the dimensions of length, breadth and thickness. Length and breadth were independently inherited, while a relationship was observed between length and thickness. Red colour of the grain was found to be a simple dominant to white colour. Awn length appeared to be inherited on a two-factor basis. In the case of glume colour, two crosses between straw and furrowed glumes behaved differently in the F_2 generation, although, in both cases in the F_1 generation, straw glume was found to be dominant to furrowed glume. In one case monofactorial segregation (3 : 1) of straw and furrowed glumes was obtained, while in the other case a dihybrid ratio (13 : 3) was noticed suggesting the operation of an inhibitory factor. The inheritance in the case of a cross between gold and furrowed glumes, however, proved more complicated and is still under study. Dwarfness was found to be a simple dominant to tallness in a cross between dwarf and tall parents.

In Cuttack (ORISSA), crosses between a salt-resistant type of *O. sativa* and *O. Coarctata*, a species growing wild in estuaries and subject to regular submergence under sea-water, are reported to have been made. The crosses, if successful, should prove interesting as the wild species has $2n=48$ chromosomes and is absolutely salt-resistant.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, the inheritance of a finely variegated type was under study. The variegated plants on selfing gave rise to variegated plants and albinos in successive generations. An occasional green plant found in the progeny of a variegated plant, however, gave greens and variegated plants in the ratio of 3 : 1. It is suggested that, in this case, while variegation is a mendelian recessive to green, albinism is transmitted only maternally through the variegated plant. Suitable artificial crosses have been made to confirm this hypothesis.

Millets

In Coimbatore (MADRAS), *Striga*-resistant strains of *jowar* (*Periamanjal cholam*) were sought to be evolved by crossing local varieties with resistant

African types. The hybrids were also back-crossed to the local parents. Genetical studies in *jowar* have shown that the dark green colour of the leaf blade was dominant to lighter colour, and the white midrib of leaf dominant to dull midrib. Two other variants in midrib character designated 'dull white' and 'streaky dull' were found to behave as simple recessive and simple dominant respectively to white midrib. A linkage between juiciness of stalk and purple colour of coleoptile and axil was established. Scent in sorghum, unlike that in rice, was noticed to behave as a simple recessive to scentlessness.

In BOMBAY, breeding work for the evolution of *Striga*-resistant *jowars* from the varieties Bilichigan and Muddinandyal was continued and selections with 90 per cent resistance were obtained. The influence of light and darkness on the germination of seeds of three *Striga* species has been ascertained and this knowledge is expected to help considerably in selecting resistant plants.

Sugarcane

In Coimbatore (MADRAS), sugarcane-bamboo hybrids are proving of considerable scientific interest and their economic possibilities were under investigation. One of these hybrids was crossed with Co 356 (sugarcane-sorghnm hybrid) and about 5,000 seedlings of the resulting trigeneric hyhrids raised. These hybrids were again back-crossed to Coimbatore canes for improving quality, and to bamboo for increasing vigour of growth in the resulting progeny. The study of the F_2 seedlings of sugarcane-bamboo hybrids has shown the presence of some plants with heavy tillering, some others with erect habit and still others with satisfactory juice-qualities. In connection with the work on breeding canes for possible use as fodder, a hybrid between *S. officinarum* and *S. halepense* was twice back-crossed to the latter parent, and vigorous plants with soft leaves have been obtained for further studies.

Cytogenetical studies were continued and results of scientific interest have been obtained. A chromosome survey of the more important Coimbatore canes has shown them to be either triploids or aneuploid progenies of triploids. A correlation between early flowering and lower chromosome number was established from a study of 76 clones of *S. spontaneum* collected from different parts of India. The pollen sterility in Coimbatore canes was determined to be due to chromosomal irregularities at meiosis. The chromosome behaviour of the cross *S. spontaneum* × *S. Barberi* was found to approximate closely to that of an autotriploid, and that of *S. spontaneum* × *S. officinarum* to that of an allotriploid with autosyndesis. The inter-relationship of *Sorghum* and *Saccharum* was brought nearer by the discovery of certain para-sorghums in which the chromosome number varied from 5 to 7. A noteworthy feature in the study of intergeneric crosses is the production of two thick canes in the F_2 generation of a cross between *S. spontaneum* ($2n=112$) and *Erianthus ravennae* ($2n=20$) both of which have thin canes. The two thick canes have been shown to be amphidiploids resulting from doubling of chromosomes in the hybrid. This important work suggests the possible origin of thick canes from hybridization of thin canes. The analysis of the progeny of a bagged cross between POJ 2725 (♀) and Imperata (♂) revealed the existence of parthenogenetically derived $2n$ plants, 'selfs', diploid and triploid besides true hybrids.

In MYSORE, the Mys-Ray selections were under trial at the Irwin canal farm, and those with good growth and high sucrose content were carried forward for yield trial. Canes obtained from X-rayed buds of Red Mauritius and Sabbannahalli striped varieties have shown greater vigour than those obtained from untreated buds. In some treated canes morphological changes were noticed, which are under study. A fresh batch of cane buds from different varieties was subjected to X-rays of varying doses with a view to obtaining desirable mutations. Out of 1,163 buds treated, 757 are surviving after transplantation.

Potato

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI and its sub-station at SIMLA, the main work in potato breeding is devoted to the production of disease-resistant varieties. In connection with breeding for late blight resistance, the back-crosses of two *S. demissum* × *S. tuberosum* hybrids were grown at Simla and selected plants were further back-crossed to the latter parent. Six new crosses were also made between *S. tuberosum* and *S. demissum* × *S. tuberosum* hybrid No. 6 which proved immune to Late Blight epidemics in 1936-37 and 1937-38, and selected plants in the progenies of these crosses were again back-crossed to *S. tuberosum*.

In connection with the study of frost resistance, a late planting of some of the available potato varieties, species, and species hybrids was made, and this trial indicated that *S. curtilobum* × *S. tuberosum* hybrid No. 5 possesses considerable resistance to frost. Hence a number of crosses between this hybrid and *S. tuberosum* were made. A few crosses were also made between *S. tuberosum* and *S. curtilobum*, which is reported to be highly frost-resistant. These crosses will be tested for frost resistance and desirable selections made.

The study of pollen fertility and sterility in all the available material was continued and the information collected has been of great help in planning out the crosses to be made. A study of the cross-compatibility of various species was also started.

Tobacco

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, cytological studies of two sterile interspecific hybrids, viz. *Nicotiana Tabacum* ($2n=48$) × *N. plumbaginifolia* ($2n=20$) and *N. glauca* ($2n=24$) × *N. plumbaginifolia* ($2n=20$) were made and the cause of sterility ascertained as being due to partial or no pairing of parental chromosomes at meiosis. Experiments to obtain fertile amphidiploids from these sterile hybrids by treatment with colchicine were in progress.

A number of crosses with *N. rustica* types were made, for the study of inheritance of nicotine content and leaf-characters, as a preliminary to the production of strains with high yield and nicotine content as such strains are expected to serve a dual purpose ; besides their use for *hooka* smoking and snuff making, they may be useful for manufacturing commercial nicotine sulphate.

The study of the incidence of leaf-curl was continued at PUSA and it was again found that protecting seedlings until transplanting time did not diminish the incidence of the disease.

Oil-seeds

Linseed. The breeding for rust-resistance was continued by the Imperial Economic Botanist, and 150 hybrid cultures were under observation at Delhi and Pusa. At DELHI the disease was practically absent, but at PUSA there was a heavy incidence of rust which provided an opportunity to test the relative resistance of different cultures. About 78 per cent of the cultures were absolutely free from rust, while others showed varying degrees of attack. Desirable single plants with a high degree of resistance were again selected for further trial. In the UNITED PROVINCES, three strains with high yield and oil content and immunity to rust have reached the multiplication stage. Some tall types have also been isolated for fibre production. At Nagpur in the CENTRAL PROVINCES, the extent of natural cross-pollination in the crop has been determined to be about 5 per cent.

Brassica. At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, work on the cultivated *Brassicae* was expanded to include cytogenetical investigations with a view to elucidating the inter-relationships and classification of the several species. Reciprocal crosses between different species were made in all possible combinations and the hybrids were under cytological study. The genetics of self-sterility in *toria* is found to be of a complex character, owing presumably to the species being a secondary polyploid. A number of chromosomal and genic mutations were isolated and were under study. The former included a triploid plant in *toria* and a haploid plant in *rai*, and the latter a male sterile mutant in *taramira*, an apetalous mutation in *sarson*, and a closed-petal mutant in *toria*. The last two mutant characters appear to be economically useful if they could be bred into self-fertile improved strains, as they would help to keep down natural cross-pollination to a considerable extent and, thus, save the strains from deterioration. Preliminary experiments to induce genetic variations in *toria* by means of X-rays were also in progress.

In the PUNJAB, various methods of group-breeding in the case of self-sterile species were practised with success. A technique for the utilization of bred bees in the pollination of self-sterile species under controlled and field conditions was developed. A number of F_1s of intervarietal and interspecific crosses were grown, the former in connection with the study of inheritance of characters like hairiness of stem, flower colour, shape of pods, position of pods and seed colour, and the latter in connection with the production of superior varieties. In the UNITED PROVINCES, improved strains of *rai* and *sarson* were continued to be bred.

Groundnut. In MADRAS, besides eight economic crosses in the F_1 generation, 16 others were under study in regard to the inheritance of characters like habit of growth, branching, duration, etc. The F_3 progenies of interspecific crosses involving *Arachis hypogaea*, *A. nambyquarœ* and *A. Rasteiro* were studied and found to contain no economic types. In BOMBAY and the CENTRAL PROVINCES, hybridization and selection were in progress in connection with the improvement of yield and oil-content.

Castor. In MADRAS, genetical studies in the F_1s of crosses have shown that spiny and warty conditions of the capsule are dominant fully and partially respectively to the smooth condition. In the CENTRAL PROVINCES

suitable crosses for evolving strains with heavy yield and oil-content were made.

Coconuts. In MADRAS, a total of 116 F_1 seedlings of crosses between tall and dwarf parents were planted during the year for study and selection of trees with high percentage of female flower production, good seed setting and thick meat.

Sesamum. In the CENTRAL PROVINCES, the problem of sterility due to phyllody was under investigation. It is suggested that selection is effective in reducing the percentage of affected plants.

Safflower. At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, DELHI, two F_1 progenies of crosses between *Carthamus tinctorius* × *C. oxyacantha* were under study. The spiny nature of the wild species and its grey seed colour were found to be dominant to spinelessness and white seed colour of the cultivated type.

Gram

In the PUNJAB, three blight (*Ascochyta rabeii*)-resistant types have been isolated from a study of about 400 collections and one of them, F 8, was multiplied for distribution to cultivators. Crosses between this type and local high-yielding varieties were also made for evolution of high-yielding strains with immunity to blight. At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, DELHI, several tetraploids were obtained by treating seeds of IP 25 with colchicine and studied cytologically.

Pigeon-peas

Breeding work for wilt-resistance at PUSA has resulted in the isolation of a strain from IP 69, which has proved superior to the parent in trials under artificial conditions of infestation. Breeding for wilt-resistance in the CENTRAL PROVINCES AND BERAR was directed to crossing resistant IP 52 and IP 80 with local types and it was found that in these crosses disease resistance was a partial dominant. A wild perennial variety strongly resistant to wilt was also crossed with local types.

Sunn-hemp

In Nagpur, interspecific crosses between *Crotalaria juncea* and *C. retusa* have been made with a view to inducing, in the former species, the good seed-setting capacity under bag, of the latter species.

Chillies

The genetics of a variegated chilli plant was under investigation at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI. The selfed seeds from the green branches of the plant gave green seedlings, while those from the variegated branches gave seedling lethals. Reciprocal crosses between green and variegated branches have been made. Colchicine treatment of seeds of IP 51 has yielded a number of tetraploids, a triploid, and a few pollen lethal mutations, all of which were under study.

4. Plant physiology

Cotton

In the PUNJAB, researches on the incidence of *tirak* or bad opening of bolls in the Punjab-American cottons, which causes partial or total failure of crops, have led to the important discovery that the condition is physiological and is due to soil conditions. A high alkali content in the sub-soil or a nitrogen deficiency in the soil tended to produce the 'disease'. The two soil conditions may be present singly or in combination in any particular field and the intensity of the 'disease' is found to vary with the intensities of these conditions. Late sowing of the crop in the first type of soils in order to reduce the vegetative growth of the plant and its water requirements, and application of nitrogen to the second type of soils, produced the desired effect and *tirak* was successfully kept under check. These results, which are of great economic importance, will be further confirmed. Preliminary investigations on vernalization of Mollisoni *desi* cotton seed appeared to indicate that plants from treated seeds will flower a month earlier than those from untreated seeds.

In MADRAS, a study of the water requirements of Cambodia during different phases of its growth under controlled conditions in pots has shown that the demand on water was greatest during the flowering phase and that it was necessary to maintain a 30 per cent moisture level (on dry soil weight basis) during the first two fortnights after sowing and that irrigation in the ninth fortnight has a markedly beneficial effect on yield. The physiological work to evolve a strain in Karunganni with a lower boll-shedding index has shown the new strain K 1 to be best suited to withstand untimely rains. Thick sowing of cotton has also been found to improve yield under conditions of untimely rainfall.

At the INSTITUTE OF PLANT INDUSTRY, INDORE, the previous year's finding, that the quality of fibre in certain American cottons is influenced by the type of land on which they are produced, was confirmed. *Adhan* (well-manured and rich) lands promote the production of finer and longer fibre of higher spinning value than *barani* (rain-fed) lands. Incidentally it was noticed that the improvement in quality of the produce from *adhan* lands was associated with a fall in ginning percentage. In competition experiments with Upland and *desi* cottons, the interesting finding, that the Upland variety suffers less and less from red-leaf and leaf-roll with increasing association with *desi*, was confirmed. There was also evidence that the Upland variety gains in yield at the expense of the *desi*, and this effect is even more pronounced when unselected types are used and also when the trial is conducted on poor lands. Experiments to find a physiological explanation for the differential survival value of the four genotypes, Malvensi, Verum, Cutchicum and Roseum, in different tracts showed again that Malvensi type is physiologically most suited to the Malwa conditions and that Malvensi and Roseum are equally suitable for the Nimar tract, but that the preponderance of the latter type in the area must be due to the human preference for Roseum on account of its higher ginning quality.

Sugarcane

In BOMBAY (Padegaon), investigations into the bio-climate in relation to cane growth have indicated that with the optimum soil moisture, which is

40 per cent and above, fluctuations in humidity are found to determine the rate of growth. As the moisture-content falls below this level, humidity is without marked effect. Soil temperatures, which show a definite tendency to rise with the progress of days after watering, are believed to be withont effect on rate of growth. Pot-culture experiments have confirmed the definite contribution of the sub-soil water-table to the water requirement of the cane crop. In connection with the field investigations into the inter-relationship of water and manure for cane growth, it has been conclusively proved that better development of the crop and higher tonnages are obtained with increasing doses of nitrogen (up to 300 lb. N per acre) in the two varieties tested, and that higher water (130 in.) for these manurial treatments has shown no advantage over the lower one (95 in.). In fact, in one of the varieties, Pundia, higher watering actually produced a deleterious effect. Drought-resistance studies have shown that varieties with thin spreading root systems are more efficient in penetrating the limited soil depth than those with thick roots which are better fitted to penetrate into deeper layers. The popular idea, that pruning roots and timely earthing up result in accelerated growth and increased out-turns of canes, has been proved to be without scientific foundation.

In the UNITED PROVINCES (Shahjahanpur), an expanded experiment to study the inter-relationship of nitrogenous manures, water duty and sowing dates with growth and yield of three cane varieties showed that the germination in all the varieties proved inferior in the early sowings, but it improved considerably in the later sowings. Not only was the germination poor, but the yield was also lower in the early-sown crop. This is thought to be due to the severe attack of *Pyrilla* on the preceding crop from which seed materials were taken. For all varieties and sowing dates, tallest canes were obtained when additional nitrogen and water were given. From the results of this experiment, the interesting inference is drawn that to enable a badly *Pyrilla*-affected seed crop to give good results, it is advisable to allow it to stand in the field for a longer time and utilize it for a late planting. Physiological studies on the nutritional requirements of plants carried out in pots indicated that the absence of nitrogen and phosphorus generally reduced plant weights. Boron and iron deficiencies had no marked effect, while the absence of calcium, potassium, magnesium and manganese individually tended to depress final weights to some extent.

At Anakapalle (MADRAS), it was observed that arrowing was earlier and more profuse in canes grown under conditions of half the normal manuring and irrigation than under normal conditions (100 lb. of nitrogen in the form of groundnut-cake and ammonium sulphate on a 2 : 1 ratio being the normal manure and watering the crop whenever required being the normal irrigation). It was also found that varieties under the former treatment recorded a high brix, sucrose and purity than under the latter. Experiments conducted at this place on ripeness of cane confirmed the previous year's results, viz. (1) flowering was not an indication of attainment of maturity, (2) there was a steady increase in sucrose content for about two to three months after arrowing, (3) arrowed canes showed a higher sucrose content than the non-arrowed ones till the time of their deterioration which set in a fortnight earlier in the arrowed canes than in non-arrowed canes, and (4) the arrowed canes gave a higher percentage of extraction, longer millable cane with greater weight,

diameter and girth. Here it may be pointed out that results obtained at BOMBAY indicated that flowered canes invariably weighed more, but they also attained maturity earlier.

At the IMPERIAL SUGARCANE BREEDING STATION, COIMBATORE, studies in photoperiodism have shown definitely that extra illumination for 250 hours with four 60 watt electric bulbs given to four and five months' old seedlings, delayed flowering by 11 days in the variety Co 285. Extra illumination given to younger plants was without any effect.

In the PUNJAB, it was again demonstrated that chlorosis in sugarcane can be corrected by either spraying 0·1 per cent solution of ferrous sulphate on the affected crop or by adding the solution to the soil.

Rice

In the UNITED PROVINCES (Nagina), preliminary experiments in pots on the water requirements of rice have indicated that drought conditions preceding the flowering time delayed flowering and reduced yields of plants. It was also observed that drought conditions in the early stages tended to make the crop better suited to withstand drought later on. Prolonged or severer drought conditions, however, had a markedly adverse effect.

In ASSAM, studies of growth and vigour in relation to flood resistance in *aman* paddies were continued with interesting results. The height and vigour of plants during the pre-flood period are not always correlated with flood resistance. Length of internode is directly correlated with abrupt water rise, while the extent of nodal branching is inversely correlated with it. Two-week-old plants are adversely affected by submergence and can hardly stand even four days' submersion. With increase in age, however, from four to eight weeks, the ability of the plants to withstand submersion increases proportionately ; plants of six and eight weeks can stand submersion up to twelve days. An experiment to determine the best time of maturity of rice grains has shown that grains harvested five to six weeks after flowering gave the highest yield and were of very good millable quality.

In ORISSA, preliminary experiments were carried out to induce drought resistance and flood resistance in rice by pre-sowing treatments of seeds. Plants raised from seeds soaked in water for 24 hours and then air-dried and kept for 24 hours at 40°C. (this treatment being repeated twice) before sowing wilted when the moisture content of the soil was 0·79 per cent, while those from untreated ones wilted when the soil had a moisture content of 1·9 per cent. Subjecting seeds to darkness and anaerobic conditions before sowing minimized the injurious effects of submersion on the resulting plants. Smoking the seeds for two to three hours on two to three successive days and dehusking them were found to be the most successful methods for breaking the dormancy in winter paddies, the latter method being more efficient and quicker than the former.

In MADRAS, investigations into the quality of rice ha e shown that application of manures, particularly organic manures, increases the thickness of the aleurone layer of the grain. To obtain good cooking and uniform expansion of the grain, it is necessary to slightly polish the grain without removing the aleurone layer. Heating shelled rice in a dry oven for two or three minutes before cooking considerably reduces the cooking time and gives

a good cooked product. It is surmised that heating has the same effect on newly harvested rice as a long period of storage, in inactivating the liquefying ferment (amylase) which causes pastiness in the cooking of newly harvested rice.

Dry-farming investigations

BOMBAY. Developmental studies of the *jowar* plant were carried out at Sholapur and Bijapur to test the seasonal effects on growth, measured in terms of height, number of green leaves and dry matter. At Sholapur the growth was found to be lower than in a good season, while at Bijapur it was higher in the deep black soil but lower in the limy soil. Tissue temperatures of leaves and internodes of *jowar* plants growing in the field were found to fluctuate with the temperatures of the surrounding air. Pruning, defoliation and removal of tillers affected adversely the growth of *jowar* plants. Vernalization of *jowar* seeds for different periods (3 to 6 weeks) did not result in any material advantage. On the other hand, the vernalized seeds were of defective germination and gave rise to plants which matured later and gave lower yields than those from untreated seeds. The water requirement in the case of vernalized plants was also greater than in that of the control.

MADRAS. Development studies conducted with two varieties of *Setaria* and two varieties of *Sorghum* showed that maximum height of plants was obtained at flowering time and maximum weight of dry matter produced was between the second and fourth week after flowering. The number of green leaves was largest at the time of internodal elongation. Studies on crop mixtures have shown that growing *Setaria* with legumes like groundnut and horse-gram was desirable, because the roots of these legumes were found to feed in the top soil, while those of *Setaria* went deeper. *Setaria*-cotton mixtures, however, did not fare well because their roots fed in the same zone. Interesting observations have been made on borer incidence in pure crops of *Sorghum* and *Sorghum*-pulse mixtures. It was found that pure plots of *Sorghum* had more attack than those in which *Sorghum* was sown mixed with groundnut. It will be interesting to recall in this connection a somewhat similar experience in cotton recorded at INDORE, where an Upland variety of cotton was found to suffer less and less from red-leaf and leaf-roll when sown in increasing association with *desi* cottons.

PUNJAB. Developmental studies at Rohtak with wheat strains 9-D (medium) and 8-A (late) have shown that the strain 9-D grows quicker, has a deeper root-system, possesses smaller number of leaves, tillers less and matures earlier than the strain 8-A. It is pointed out that 9-D or similar medium-ripening varieties are better suited to dry-farming conditions than 8-A or similar late varieties. Similar studies have shown *bajra* local (early variety) to be better suited to dry conditions than *bajra* A $\frac{1}{3}$ (late variety). Early varieties of wheat, gram and *bajra* appear to have higher values of transpiration coefficient than the late ones, but the latter require more water. Vernalized *jowar* produced ears six days earlier and yielded more than the control, a result apparently contradictory to that obtained in Bombay.

Other physiological investigations

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI, wheat and gram were successfully vernalized and significant results obtained. 'Chilled' seeds of gram were grown under (1) natural conditions, and (2) under

different photo-periods (short, natural and long day conditions). In the first experiment plants from treated seeds started initiation of the flower buds 15 days earlier than the control plants and maintained this difference through subsequent phases of development up to maturity. In the second experiment the control and treated plants grown under 'long day' conditions flowered almost simultaneously, but earlier than the others in the series. In the case of wheats, the influence of 'long days' in inducing early flowering appeared to be more marked than 'chilling'.

Experiments carried out for shortening the rest period of potato showed that exposure of tubers for varying periods to carbon bi-sulphide vapour and smoke was without any advantage.

In MADRAS, developmental studies carried out with groundnut have shown that short duration bunch varieties start flowering about the 23rd day after sowing and exhibit a high rate of flower production forthwith, which diminishes after about four weeks time. In the spreading varieties, flower production appears to be in two waves, the first one, which coincides with the flowering of the bunch types, being followed by a second feeble flush which extends up to a month or more depending on the rains. In some other varieties continuous flowering without any pronounced flushes was also noticed.

In the PUNJAB, investigations to find out a remedy for poor fruiting of santra trees have shown that the simple process of 'ringing', which simply consists in removing the bark in a band of about half an inch thick around five or six main branches, to be very effective.

In BIHAR (Sabour), encouraging results have been obtained from preliminary experiments with growth-promoting substances designed to stimulate rootings in cuttings of litchi and mango.

Several investigations dealing with the physiological and metabolic responses of crop plants to various conditions determining growth and development were in progress at the BENARES HINDU UNIVERSITY, and the results obtained have been published in various journals. A reference to only a few of these investigations is made here. Photo-periodic studies have established that under 12 hours illumination plants fail to grow normally. Development of chlorophyll and production of dry matter dwindle and flowering and maturation are delayed. Plants grown under very short durations of light die prematurely. It has been found that *Crotalaria juncea* thrives best in 12 hours illumination, while *Gossypium* and *Triticum* require 15 hours and *Linum* and *Brassica* 18 hours daily illumination for best growth. In the field of water requirement it has been shown by means of manurial combinations that a fairly marked relationship exists between water-requirement of plants and the degree of soil fertility. Increasing the fertility of the soil by addition of manures reduced the quantity of water needed for unit dry matter production but enhanced the total quantity of water transpired by the crop. The respiration of potato tubers during storage was also under detailed investigation.

5. Plant diseases

Soil-borne diseases and root diseases

A certain amount of work has now started in India in what has become a very popular study for plant pathologists in many countries, namely plant-

disease control by fungous antagonism or 'biological control'. In MADRAS it was found that complete control of *Macrophomina phaseoli* (Maubl.) Ashby causing foot-rot of cow-peas could be brought about in artificial inoculation experiments in which *Trichoderma lignorum* (Tode) Garz. was mixed with the *Macrophomina* used as inoculum. Filtrate of liquid cultures of *T. lignorum* proved toxic to cultures of *M. phaseoli*. Much advanced work on the toxic principle of *T. lignorum* has been done in America, and biological control has been tried in many countries by numerous workers. Its applicability under Indian conditions is also being studied at DELHI.

It is claimed that there is a reduction of the flag-smut fungus (*Urocystis tritici* Koern.) of wheat in the soil in the PUNJAB as a result of growing sorghum or green-manuring the soil with sunn-hemp. This again suggests the possible operation of biological antagonism.

Further advances have been made in the study of cotton root-rot under the schemes of the Central Cotton Committee. In the PUNJAB the root-rots caused by *Rhizoctonia solani* Kühn. and *Macrophomina phaseoli* respond differently to changes of temperature. Root-rot due to the former is reduced considerably by lowering the temperature, but no such reduction occurs in the case of the latter disease. Mixing sorghum in the cotton crop is said to lower the incidence of the disease and this is believed to be due to reduction of air temperature and raising of humidity. A similar effect has been obtained by planting *bajra* (*Pennisetum typhoideum*) with cotton in BARODA. In the Punjab, cotton sown very early (early April) or very late (after the middle of June) suffered less from root-rot than that sown in the hottest season of the year. By supplementing the adjustment of sowing date with other measures, such as removing diseased debris, manuring and giving heavy irrigations, it has been found possible to reduce the incidence of root-rot to negligible proportions as compared with May sowings. In Baroda, work on resistance of varieties of cotton to root-rot was continued.

Both *Botryodiplodia theobromae* Pat. and *Macrophomina phaseoli* are capable of causing the root disease of coconut palms in TRAVANCORE. Arecanut palms also suffer from the disease. It was suspected that deficiency of plant nutrients in the soil rendered the palms susceptible, and in consequence large numbers of soil samples were collected and analysed. Deficiencies of nitrogen, potash, phosphorus and lime were found. It will be of interest to learn whether this is the true cause, or whether the prevalence of root-rot is simply due to an accumulation of the fungi in the soil resulting from continuous growth of a susceptible host over a period of many years, because on the answer to this question depends ultimate control of the disease.

Experiments in BOMBAY to study the relationship of cotton wilt to soil moisture confirm the previous conclusion that it is most severe when the moisture is 40 to 60 per cent of the water-holding capacity.

It has been found in Bombay that wilt of *long* (*Lathyrus sativus*) is most severe at 25°C., a fairly low optimum for *Fusarium* wilts in India.

Experiments made at DELHI indicated that the wilt disease of gram develops most rapidly at comparatively high temperatures. This result, obtained in a pot experiment, was confirmed in the field, where gram was planted at weekly intervals commencing on September 23. The severest wilting occurred in the plots sown on September 30, after which it rapidly fell off.

It was found that a pycnidial fungus (quite distinct from ***Mycosphaerella rabiei*** Kov., the cause of gram blight) brings about a disease of gram reminiscent of that caused by *Fusarium*.

Experiments at Delhi with isolates of *Fusarium* from wilted cotton, pigeon-pea and sunn-hemp plants, confirmed that the organisms causing wilt of these three crops are physiologically distinct. In the case of organisms causing seed-rotting or pre-emergence blight, however, this was much less marked.

In Bihar maize plants showing signs of a severe attack of root-rot were found to be invaded by a *Pythium*. Inoculation and re-isolation proved its pathogenicity. It is of special significance as a species of *Pythium* causes a serious root-rot of maize in the United States of America.

In experiments made in Bengal, artificial infestation of soil, in which cinchona seeds were planted, with a number of isolates of *Fusarium* obtained from the diseased roots of this host, failed to reproduce the seedling disease. Similarly, attempts made at Delhi to infect the roots of *Citrus* spp. with a large number of isolates of *Fusarium* from the roots of trees sufferiug from die-back were unsuccessful.

Leaf and stem diseases

In the Imperial Council of Agricultural Research scheme of research on diseases of sugarcane, 41 varieties were tested for resistance to red-rot (*Colletotrichum falcatum* Went.) and wilt (*Cephalosporium sacchari* Butl.). Possibly owing to the universally dry conditions prevailing during the summer of 1938, the progress of infection was slow. The most susceptible varieties were, in the case of red-rot, Co 362, 531, 299, 526, 223, 417, 419, 421, Co K 10, Co K 22 and Dehra Dun Ponda and in the case of wilt, Co 421, 441, 419. 413, 331, 360 and 528.

In Madras, 11 varieties of sugarcane were tested for resistance to red-rot. All the varieties except Co 281 proved highly susceptible. A separate experiment was conducted to find the rate of spread of the fungus from infected setts to new shoots. In the variety Vellai the rate of spread from sett to shoot was extremely rapid, whereas with POJ 213 there was no spread even after 3½ months. This is particularly interesting because POJ 213 happens to be the variety which almost went out of cultivation due to the red-rot epidemic in America in 1930. A dark-coloured strain of the fungus occurs in Madras and is presumably the one used in the experiment. This perhaps explains the behaviour of POJ 213, since it was a light-coloured strain which caused the epidemic in America.

In the summer of 1938 there was a severe outbreak of red stripe (*Pseudomonas rubrilineans* Lee et al.) of sugarcane in one district of the Punjab. It caused complete killing and rotting of the tops of most canes, and even in those cases where new buds were put out, they also later took infection. After October there was no further spread of the disease. The incidence of the disease on a number of varieties was recorded. Very se ere infection occurred in Co 312.

In Madras, gummosis of citrus occurred in severe form in nurseries in 1938. The root-stock 'gajanimma' was found to be particularly susceptible. The application of Bordeaux paste in the early stages of the disease was found to give good control

According to work done at the Horticultural Research Sub-Station at Montgomery, PUNJAB, *Colletotrichum gloeosporioides* Penz., the cause of wither-tip disease of *Citrus* in the Punjab, is distinct from *Gloeosporium limetticolum* Clausen, which causes a similar disease of *Citrus* (limes) in America and elsewhere. 'Large-scale inoculation experiments' with the latter fungus, obtained from Holland, are reported. Since the two fungi have been recognized as different by some workers since 1912 and *G. limetticolum* apparently does not occur in India, it seems to be undesirable to carry out large-scale inoculation experiments, for the fungus is one which spores abundantly and prevention of its spread may prove difficult. Various fungicides tested failed to control the wither-tip disease. It is believed that there is a correlation between soil conditions and severity of the disease.

In MADRAS, various cross-inoculation tests have been made with species of *Helminthosporium* isolated from various hosts. Generally speaking, the three species, *H. tetramera* McKinney, *H. nodulosum* Berk. and Curt. and *H. sativum* P. K. and B., caused heavy infection only on hosts from which they were isolated, but *ragi* (*Elusine coracana*) and wheat *Helminthosporia* were able to infect barley, oats, *cumbu* (*P. typhoideum*), *tenai* (*Setaria italica*) and maize to some extent. All proved to be rather high temperature organisms, the optimum being in all cases about 30·5°C.

Various cross-inoculation tests were made with species of *Phytophthora* isolated from areca, palmyra, citrus and tobacco in MADRAS. Since various cross-inoculations proved successful, it is obvious that the *Phytophthora* isolated from areca palms cannot be assumed always to be *Phytophthora arecae* (Coleman) Pathy. nor that from palmyras always *P. palmivora* Butl. Those isolated from areca, citrus and tobacco all failed to attack unwounded palmyras, whereas that isolated from palmyra produced infection. Various distinctions could be found in the behaviour of these on other hosts, such as potato tubers, tomato and papaya seedlings, apple and citrus fruits, etc. It is to be hoped that this work will be continued and the results concisely and systematically published as it may then throw valuable light on controversial problems connected with this rather difficult and very harmful group of fungi.

In MADRAS, 36 varieties or strains of paddy were tested for resistance to '*blast*' (*Piricularia oryzae* Cavara). The strain Adt 6 was found to be highly resistant. In order to study the effect of the disease on yield in relation to the date of sowing, monthly sowings were made in September, October and November, and the later sowings suffered the least damage. It was also noticed that in the September plantings the late-flowering varieties suffered less than the early ones. In infection tests, the varieties Co 4 and Co 11, normally considered resistant to blast, took 12 per cent and 17 per cent infection respectively, while under ordinary field conditions the variety GEB 24, also considered resistant, had 32 per cent infection in one place and 49 per cent in another. The possibility that there exist physiologic forms of the fungus with different pathogenic capacities therefore appears. The fungus was found to survive in pulverized paddy soil up to 13 months.

In ASSAM the paddy varieties Thaborn and Zdulake were found free from blast though growing adjacent to a severely attacked crop of the variety Khasti.

Ragi blast has also received attention, and of the 15 varieties so far tested none has proved resistant. The species of *Piricularia* concerned failed to infect paddy or ginger, but attacked young seedlings of wheat, oats and barley.

The cotton seedling blight and boll rot caused by *Colletotrichum indicum* Dastur was studied in MADRAS. All the Asiatic cottons tried were found to be susceptible, and all the exotic varieties resistant. It was found that the disease may be carried in the seed and that soil infection may also take place. The fungus was found to grow best at a temperature of 32°C.

A disease of branches of tea plants is reported to be widespread and serious in TRAVANCORE. It is a typical canker disease, caused by the fungus *Nectria subquaternata* Berk. and Br. It is believed that plants become susceptible through a general lack of vitality. While control is ultimately considered to rest in improving the general vigour of the plants, attention is also being paid to pruning out infected branches and spraying. A die-back disease also occurs, though it is less serious than canker. The fungus concerned is *Leptothyrium theae* Petch, which causes serious trouble in Ceylon.

Work was continued at the Hill Fruit Research Station, Chaubattia, UNITED PROVINCES, on the stem-black disease of apples caused by *Coniothecium chomatosporum* Corda. Pastes made of red lead and copper carbonate with either linseed oil or lanolin proved useful for treatment of pruned surfaces, but although lanolin hastened callus formation, it alone did not check the entry of the fungus. The red lead-copper carbonate mixture painted on forks of apple-tree branches controlled the pink disease caused by *Corticium salmonicolor* B. and Br.

The work on cereal rusts was continued under the auspices of the Imperial Council of Agricultural Research. An interesting side of the work has been the development of the study of the relationship between various species of *Berberis* and the stem rust, though it was hampered to some extent by inability to secure suitable material of some of the species wanted for the investigation. Young leaves of *Berberis lycium* and *B. aristata* readily developed aecidia, but *B. petiolaris* failed to do so even in the case of leaves only three days old, while on *B. tinctoria* spermogonia only were formed.

The loss of infectability of *B. lycium* leaves is explained on the basis of thickness of the outer epidermal wall and the cuticle. In a 12-day-old leaf this was found to average 1·54471 μ, whereas in the case of *B. vulgaris* it was 1·36298 μ. In the case of *B. aristata* and *B. coriaria* infection failed at the age of five days when the thickness was found to be 1·42017 and 1·57970 μ respectively. The average measurements were carried to the fifth place of decimal (i.e. one hundred thousandth of a μ). Such figures have no real meaning. The difference of just over 0·1 μ recorded for *B. vulgaris* and *B. lycium* are within the limits of experimental and personal error of a skilled worker with the most accurate modern contrivances, and no acceptable evidence has yet been put forward to the effect that resistance is dependent on a thick cuticle. Perhaps something more convincing will be produced when the study of *B. petiolaris*, of which insufficient material was available, becomes possible.

Out of a total of 1,058 wind curves studied, 41 have been found significant. Such winds are regarded as significant 'as had passed during their course over stations where the rust in question had appeared at least a fortnight earlier and reached the station concerned at least a fortnight before the earliest date of its appearance on the local crop'. It is not stated in how many cases

rust appeared at stations in the absence of 'significant winds', nor is it stated whether the period of a fortnight has any scientific basis or is a purely arbitrary figure.

Breeding resistant varieties of crops

The breeding of rust-resistant varieties of wheat for the hills was continued. Three crosses were made for this purpose for each type of rust (stem rust, brown rust and yellow rust). In the fourth generation 1,702 plants out of 2,640 proved to be resistant. The first generation of seven other crosses was tested and seedlings of all of them were highly susceptible to stem rust, illustrating the general rule that susceptibility is dominant over resistance. Four new crosses were made. A start was made in the attempt to correlate resistance with certain characters in the wheat plant, namely, presence or absence of leaf hairs, time and duration of opening of stomata and internal structure of the stem.

The selection of varieties of wheat resistant to smuts, being done at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE since 1936, has now reached a stage where it is possible to get some idea of the likelihood of success. Out of six varieties found in the previous year to be resistant to loose smut, five continued so, while three further selections made from varieties showing low infection in the previous year developed none this season. Out of 48 additional varieties tested, 14 showed no infection. From the 97 varieties tested for resistance to flag smut, 24 gave no infection in spite of the fact that it was very severe (up to 88 per cent) in some varieties. Four varieties of oats have shown complete resistance to smut.

Breeding cotton for resistance to wilt continues successfully in BOMBAY. Highly resistant types suitable for the Broach area have arisen from the cross B D 8 × S 7-1 and the back-cross (B D 8 × G A 26) × B D 8. Selections from other crosses are being worked up for the Khandesh tract, and various other cultures and crosses are under test. Crosses have been made between highly resistant and highly susceptible varieties of cotton to study the mode of inheritance of wilt resistance.

The progeny of five plants of *long* (*Lathyrus sativus*) obtained from Indore were tested in Bombay for resistance to *Fusarium* wilt. Progeny of single plants from Type 1 and Type 148 suffered no mortality from wilt.

The valuable commercial variety of banana Basrae and the variety Kali proved highly resistant to Panama disease in Bombay, whereas the local variety Sone was very susceptible.

Fungicides and disease control

It is reported from Assam that treatment of paddy seed with Ceresan before sowing did not give promising results in the control of *Fusarium* foot-rot. Further experiments on seed treatment are promised. Elsewhere it has been found that mercurial seed dressings are useful for this purpose. Good control of bunt of wheat (*Tilletia foetens* (Berk. and Curt) Tael) was obtained with both Ceresan and Agrosan in BALUCHISTAN. In the CENTRAL PROVINCES it has been found that seed dressings increase the yield of cotton from 10 to 30 per

cent. The blight caused by the anthracnose fungus is controlled by delinting the seed with sulphuric acid.

Sugarcane smut was studied at the sugarcane research stations in the PUNJAB (Risalewala and Jullunder). It has been confirmed that immersion of setts in a 0·1 per cent solution of mercuric chloride or a one per cent solution of formalin, followed by covering for two hours with a moist cloth, kills the spores without damaging the setts, but it is not clear from the report whether this refers to artificially inoculated setts in which the spores are quite superficial or to naturally infected setts in which the mycelium has already gained entry into the buds.

It is pointed out that the effectiveness of the solar heat method of controlling loose smut (*Ustilago tritici* (Pers.) Jens.) of wheat may not be so successful in the hills as on the plains of the Punjab, where the temperature is higher, and experiments are being laid out to ascertain this point. In the CENTRAL PROVINCES grain smut of sorghum (*Sphacelotheca sorghi* (Link.) Clinton) was reduced from 20 to 5 per cent by exposure of the seed to the sun for five hours.

In MYSORE, types of spraying apparatus continue to attract the attention of the department of agriculture. For the control of *koleroga* disease of areca-nut palms it is found that although spraying with a jet nozzle is rapid, it fails to give a uniform spray cover and also results in much wastage of the spray mixture. It is stated that many garden owners have taken to the use of spray nozzles.

Experiments on *Citrus nobilis* leaf-fall and fruit-rot caused by a species of *Phytophthora* in MADRAS showed that the disease could he controlled by spraying with one per cent Bordeaux mixture even after the outbreak of the disease had commenced.

In BOMBAY, it was found that while one application of 300-mesh sulphur dust would control powdery mildew of betel vine in new plantations, it was necessary to give two applications in older established gardens.

It is interesting to learn that an attempt was made to control the *karikaddy roga* disease of paddy, cansed by *Ephelis oryzae*, by flooding the crop 75 days after transplantation with a copper sulphate solution of strength 1 lb. in 6,000 gallons of water. It brought about some reduction in the incidence of the disease. Possibly the method might be extended to some other diseases.

Soil fungicides are most useful in small seed-beds, and it is interesting to learn that cheshnut compound, which is widely used by glasshouse growers in temperate climates, controlled damping off of tobacco in BOMBAY. Cuprous oxide used as a seed dressing at one ounce of dust to four pounds of seed was ineffective, a fact which is not surprising as the only chemicals which have been successful when applied to the seed for controlling soil-borne diseases have been mercurial compounds, and even they are usually only partially successful.

Nutritional disorders

Mottle-leaf of Mosambi (*Citrus sinensis*) showed a promising response to application of zinc sulphate-lime mixture (5—2½—50) to which casein or Agral I or II was added as spreader, confirming the findings reported last year.

Similar results were obtained in MADRAS with *Citrus sinensis*, *C. nobilis* and *C. decumana*, and also in the CENTRAL PROVINCES.

A new type of 'yellowing disease' of sugarcane was found at Jullunder, PUNJAB. Whereas a similar type of chlorosis was controlled effectively in Panipat by spraying the plants with a 0·1 per cent solution of ferrous sulphate, such treatment was ineffective at Jullunder, and the cause of the disease has not yet been determined.

Virus diseases

The work on 'little-leaf' disease of brinjal in Madras has shown that it may be successfully transmitted to tomato, tobacco, *Datura fastuosa*, *Solanum xanthocarpum*, *S. torvum* and *S. trilobatum* by grafting, and the symptoms are the same in all cases. The disease is successfully transmitted by a jassid, *Eutettix phycitis*. This insect has been found in nature feeding on *Solanum xanthocarpum* and *Datura fastuosa*, as well as on brinjal.

A leaf-curl disease of papaya has been found in Madras. It is transmissible by grafting.

Owing to the fact that mosaic disease is absent from cardamom plantations in Zelliampathies, steps were taken to prevent importation of living plant material other than true seed into the district.

The leaf-curl disease of tobacco has been found to manifest itself only after the plants have attained a fairly advanced stage of development. Exposure or protection of the seedlings prior to transplantation has been found to make little difference to the subsequent occurrence of the disease in the field. The disease may be readily transmitted to tobacco plants from a number of different hosts, including *Zinnia elegans*, *Solanum nigrum*, *Euphorbia hirta*, *Vernonia cinerea*, *Lycopersicum esculentum*, *Launea asplenifolia*, *Sida rhombifolia*, and *Sida humilis*. The white-fly vector, *Bemisia gossypiperda*, was found feeding on about 75 plants. It has not yet been determined how many of these carry the leaf-curl virus. Attempts to transmit the leaf-curl disease to tobacco plants by means of white-flies fed on the extracted juice of infected plants were unsuccessful.

It was found that the amount of natural transmission of sugarcane mosaic varied greatly with the locality. It occurred at Gorakhpur, Muzaffarnagar, Jullundur and Gurdaspur, and to a slight extent at Shahjahanpur, Karnal and Lyallpur. It has not so far been found at Pusa, Delhi or Nagina. *Aphis maidis*, which has been proved to be the insect vector of sugarcane mosaic in other countries, was found colonizing on the variety Shakarchinya.

A disease of bananas possibly the same as the devastating 'bunchy-top' which has caused so much havoc in Australia and other countries has appeared in Cuttack, Orissa, and in the districts of Golaghat and Sibsagar in Assam. Early measures will be necessary if the disease is to be prevented from spreading.

Phanerogamic parasites

Some success has been achieved in the search for *Striga*-resistant strains of sorghum in BOMBAY. Selections from the varieties *bilichigan* and *muddinandyal* gave strains with 90 per cent resistant plants.

It has been found that species of *Striga* vary greatly in the response of their seeds to light and darkness. Seeds of *S. densiflora* germinate only in darkness, and those of *S. euphrasioides* only in light. *S. lutea* seeds germinate in light but better in darkness.

6. Entomology—Insect pests

(*a*) Locusts

Observations on the desert locust (*Schistocerca gregaria* Forsk.) and the migratory locust (*Locusta migratoria* ph. *solitaria.*) were continued in Rajputana, Sind, western Punjab and Baluchistan during 1938-39. The locust investigation scheme, which was started in 1930 under the auspices of the Imperial Council of Agricultural Research, terminated on 31 March 1939, when the work was taken over by the Government of India and put under the supervision of the Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi. Thus a Locust Warning Organization has been established in the country on a permanent basis.

A. The desert locust

No swarm was reported anywhere in India during the year. Locusts continued to be scarce till March 1938 in the Thar-Mallani tract and in the Sardarshahr area. Though uo locusts were found in the winter of 1937-38, in the Kachhi-Bolan area, small numbers were noticed in March 1938. Thin concentrations of hoppers were found in the Bolan and Harnai tracts during April-May. Light breeding was noticed in March-April on the Mekran coastal reks due to moderate rainfall during the winter months, and by April-May in the interior valleys of Mekran also.

The monsoon burst abnormally early in the middle of May 1938, but was scanty later on. There was but little rain iu July and August and none at all in September. Light migration of locusts took place in the desert area of Sind-Rajputana and also round about Pasni during June-July. Later on, due to scarcity of rains, breeding was restricted to a few places where rainfall had been received. Lasbela received fairly good showers in August. Some breeding was, therefore, observed aloug the coast. In September-October, fair numbers of locally produced adults were noticeable on the Ambagh-Sonmiani reks though there was no evidence of migrants from outside.

By the end of October 1938, small numbers of new generation adults noted in Thar disappeared and no locust was found anywhere iu Sind-Rajputana after October. Since breeding was negligible, there were presumably few locusts to migrate from here aud consequeutly there was paucity of migrants in the Mekran-Lasbela area in the autumn of 1938. In winter (1938-39) small numbers of locusts were seen on the coastal areas of Lasbela, few in Mekran area and none at all in Sind and Rajputana areas.

With the widespread precipitation in Mekran during spring of 1939, the over-wintered adults in the coastal region became active. Fair amount of breeding was observed in Kulanch and Kalmat-Makola areas during May and June respectively. The maximum locust population recorded in these tracts was 5,000 per sq. mile. Locusts were also found in Turbat and Panjgur, but there was no appreciable breeding. Fair amount of breeding occurred round

about Pasni in June when the population was 1,540 per sq. mile. In the Lasbela State, active breeding was observed at a number of places and a population of 5,400 per sq. mile was found at Chandragup and Kund in June. The above precipitation extended also to northern Baluchistan where it induced breeding in the Kachhi area. Owing to isolated mode of cultivation in this area, the population rose to 19,200 per sq. mile between Bhag and Ghadi during June.

The Rajputana desert received some rainfall in June and a few locusts were noticed at Nokh, Sardarsbahr and Bikaner. They were presumably migrants from the winter rainfall area, particularly the Kachhi district.

Laboratory investigations on the biology and physiology of the desert locust were continued at Lyallpur. Some of the important conclusions reached during the year are given below :—

(i) *Food preference :* Small swarms bred in cages were observed to concentrate on citrus plants which were defoliated and the bark eaten up. . On the other hand, *shisham* (*Dalbergia sissoo*) trees which stood adjacent to citrus trees were untouched.

(ii) *Incubation and soil moisture :* Minimum soil moisture for development of eggs was observed to differ markedly with the texture of soil.

(iii) *Development of gonads at some constant temperatures :* Comparative study of food and fat development made on the adult locusts showed that lower the temperature the more favourable it was for fat development. There was no correlation between the size of testes and temperature, but there was some connection with the size of ovary. Ovary was smallest at 27°C. and well developed at 37°C.

B. Locusta migratoria ph. *solitaria*

Large number of adults were observed in the irrigated wheat fields in Bolan and Harnai valleys in March 1938. By May, some of the crops and grasses were found heavily infested with hoppers and by July only few specimens were to be seen. Breeding was also observed during May-June in Loralai and Kohlu. During the monsoon period, light breeding was noted in parts of the Bikaner Canal Colonies and in parts of the south-east Punjab. A few specimens of the locust were noticeable almost everywhere in Rajputana desert during summer and even in autumn.

In Sirohi-Mehsana areas, comparatively small numbers of adults were found in September-October in contrast to the heavy multiplication reported in October 1937. In the Lasbela and Habnadi areas, some breeding was noted in September-October, bnt few adults were noticeable in December.

The locust then remained absent almost everywhere till June 1939 when a few specimens were discovered in Panjgur, Lasbela area and Bolan valley.

(b) Other insect pests

Cotton. *In the laboratory of the Imperial Entomologist at* NEW DELHI the fecundity of adults and development of immature stages of *Earias fabia* Stoll and its parasite *Microbracon lefroyi* (D. & G.) were critically studied under controlled conditions of temperature and humidity. The upper vital limit for the host lies at about 40°C., that for the parasite a little above 35°C. Temperatures between 35° and 45°C. and the duration for which they prevail

in nature are important factors which determine the host and parasite populations. Between 16° and 35°C., the parasite develops 2-2½ times faster than the host. The eggs and pupae of the host develop best under a saturation-deficiency of 3 mm., whereas the parasite requires an almost saturated atmosphere.

It is well known that during years of good rainfall the spotted bollworms are not serious on cotton. The work referred to above indicates that it is not so much the mechanical effect of rain which is beneficial, as hitherto supposed, but that summer rains help in controlling the pest by lowering the temperature, which is beneficial to the parasite, and by raising the humidity, which is injurious to the host.

As a result of the clearing of cotton stubbles and alternate host-plants of spotted bollworms during the off-season in an area of 500 sq. miles in Lyallpur and Jhang districts of the PUNJAB, it was found that the yield increased by about 3½ md. per acre.

At Parbhani (HYDERABAD-DECCAN), observations on spotted bollworms of cotton showed that damage to green buds and bolls was rather low up to the end of October due to heavy showers of rain received during the previous months. In order to control these pests a campaign of clearing up cotton stubbles and other alternate host plants was carried out in 230 villages in Nanded district and also in Baroda, Surat, Broach and Panch Mahal with good results.

The incidence of spotted bollworms in the shed buds and bolls in Cambodia cotton was also studied in MADRAS. Most of the shed bolls were found to have been attacked by *Bacterium malvacearum*, while the bollworm incidence was very low.

In the UNITED PROVINCES, about 18,865 md. of cotton seed meant for sowing was sun-heated to destroy pink bollworms hibernating therein. As a result of this, it was found that there was an increase of about 64 per cent in yield over that from the untreated areas. In another area in the province, the average yield of cotton per acre in the treated area was 9 md. 7 sr. against 3 md. 15 sr. in the untreated area.

Leucopis griseola Fall., a new important predator of the cotton aphid, *Aphis gossypii* Glover, was discovered and studied at NEW DELHI. The predator appears in the field in November and December. During winter, the egg, larval and pupal periods last 4-7, 16-21 and 29-49 days respectively. The larvae undergo three moults. The adults when fed on sugar solution lived 6-8 weeks.

Previous work in the PUNJAB had shown that rosin compound was the most effective spray for controlling the cotton white fly, *Bemisia gossypiperda* M. & L. During the year investigations were directed mainly to determine the number of sprayings required to rid a field of the pest. It was found that even with six sprays it was not possible to keep a plot absolutely free of the white fly, because, firstly, the insecticide did not kill all the eggs and pupae, and secondly, large migrations of adults from other crops reinfected the treated plants.

In SIND, work under a scheme to investigate the cotton-jassid problem, financed by the Indian Central Cotton Committee, was started in May 1938. Two species, viz. *Empoasca devastans* Dist. on cotton, *bhindi*, brinjal and potato and *E. formosana* Paoli (?) on *Cyamopsis psoralioides*, *Dolichos lablab*, *Vigna catjang* and *Trifolium alexandrinum* were common in the province. The biology

of *E. devastans* and its comparative incidence on different cottons was studied.

Gryllulus domesticus Linn. proved a serious pest of germinating cotton in some parts of Sind. A survey of the affected areas has been carried out to ascertain the species responsible for the damage and work on the biology and control of the pest is in progress. The bionomics and control of *Gryllulus domesticus* Linn., a serious pest of cotton and other *kharif* crops in Usta colony of BALUCHISTAN, was studied in detail. The pest was controlled by spreading bait consisting of 20 parts of wheat bran, and one seer each of sodium flousilicate and molasses mixed with enough quantity of water to moisten the mass. The cost worked out at about a rupee per acre.

Studies on the cotton stem weevil, *Pempheres affinis* Faust., and some of its parasites, e.g. *Spathius* sp., and *Dinarmus* sp. and on its alternate host plants were continued at Coimbatore in the MADRAS Province. In MYSORE, the cotton weevil was noticed for the first time. It probably entered the Mysore State from the adjoining Coimbatore district. In some areas the infestation was very severe.

Paddy. The silver-shoot gall midge of paddy, *Pachydiplosis oryzae* Mani, was reported to be bad in the Belaghat district of the CENTRAL PROVINCES, where it is claimed to have been controlled by the light-trap method.

The paddy leaf-roller, *Cnaphalocrocis medinalis* Guen., appeared in a severe form for the first time in the COCHIN State. Cutting of the top halves of the affected plants and destroying them and application of a stimulating manure, such as ammonium sulphate, gave good results in controlling this pest.

The rice stem-borer, *Schoenobius incertellus* Walk., is a very serious pest of paddy in many parts of India. In TRAVANCORE it is reported to appear in a pest form year after year during the season when the *kumbhom* variety is in the field. The estimated damage to paddy in south Travancore is about 10 per cent of the total out-turn. The only effective method of controlling it is to pull up and destroy the affected seedlings. During the year in over 200 acres of nurseries and over 900 acres of transplanted fields the affected seedlings were destroyed. As usually there are 10 cents of nurseries for transplanting on one acre and as over 200 acres of such nurseries were treated, the estimated area of crop thus saved was about 2,000 acres. Also over 900 acres of transplanted fields were treated; thus a total area of about 3,000 acres of paddy fields was saved from the damage of the pest. The out-turn from this area is estimated to be worth Rs. 1,51,500. Thus a loss of about Rs. 1,51,500 was averted by spending only Rs. 240 on control measures.

The rice hispa, *Hispa armigera* Oliv. (=*H. aenescens* Baly), was bad on deep-water paddy in ASSAM and BENGAL. This pest thrives on several alternative food plants in both these provinces and is thus present all the year round; but it was rather severe in Assam in April and the damage continued till August. Various insecticides were tried and pyrethrum dust and 'pyrocide 20' spray proved very effective against the pest in Assam. Though these control operations were interfered with by rain, the effect of dusting and spraying was fairly well pronounced. Bagging was tried against this pest with good results in the Hoogly district in Bengal.

Fruit pests. Under the supervision of the Imperial Entomologist, the fruit-fly, *Dacus ferrugineus* Fabr., a major pest of several fruits, e.g. loquat; apricot, peach, pear, guava, etc. in the NORTH-WEST FRONTIER PROVINCE

FIG. 2 & 3 much enlarged

THE SAN JOSÉ SCALE

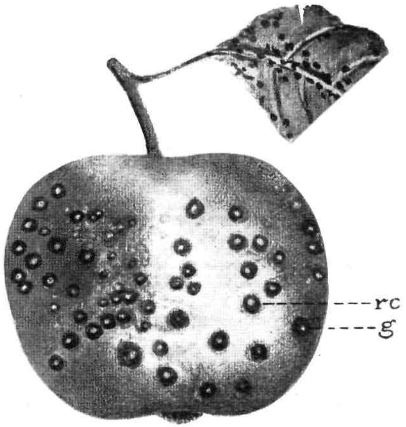


FIG. 1
An apple fruit attacked by San José Scale. A greyish scale (*g*) covering a female can be seen in the centre of red circular areas (*rc*) on the skin of the diseased fruit.

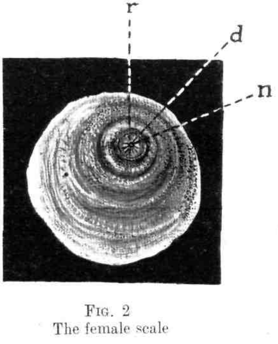


FIG. 2
The female scale

FIG. 3
The male scale greyish in colour elongated in shape and with the nipple situated to one side

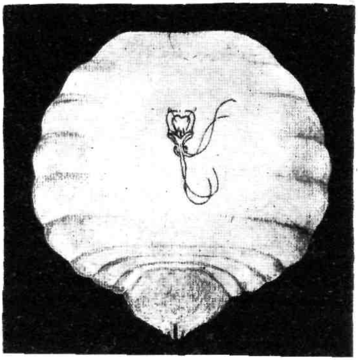


FIG. 1. The body of a female—oval-shaped and of yellow colour

THE SAN JOSÉ SCALE

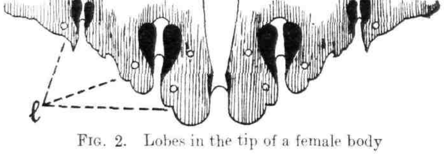


FIG. 2. Lobes in the tip of a female body

was further investigated. An enormous range of colour variation was found in the collections of the flies made in the orchards and those reared in the laboratory. After a close study of the three colour forms, viz. the light, the dark and the intermediate forms, at present occurring in the north-west India, it has been concluded that they all are *Dacus ferrugineus*. The lures tested during the previous year were tried again on a very large scale and Clensel, a proprietary insecticide and pollard bait prepared from wheat bran, borax and water were found to be almost equally effective in attracting the flies. The trap devised for using these lures proved as good as last year.

In the MADRAS province, the fruit flies *Dacus correctus* Bezzi and *Carpomyia vesuviana* Costa did serious damage to *ber* (*Ziziphus jujuba*) fruits. Trapping the flies by lures, such as amyl acetate, citrol, citronella oil, lemon grass and Clensel or spraying the trees with poisoned molasses did not reduce the population of flies to any appreciable extent. Destruction of puparia by raking up the soil underneath the trees was found to be a useful control measure.

A survey of the fruit pests of the PUNJAB and the NORTH-WEST FRONTIER PROVINCE with particular reference to the San Jose Scale was in progress. At Nagwain (Mandi State), the San Jose Scale was observed for the first time on Alder (*Alnus nepalensis*). Other new pests recorded during the course of survey were *Brachycaudus pruni* Koch, damaging peach foliage, *Apriona cinerea* Chev, tunnelling peach stem and *Mimastra cyanea* Hope on mulberry, plum and apricot.

In the Kulu Valley (PUNJAB), a winter spray consisting of a mixture of diesel oil, lime and copper sulphate for controlling the San Jose Scale has been found effective. Spraying with rosin soap was found to be effective against the woolly aphis. The biological control of the woolly aphis by its parasite, *Aphelinus mali* Hald gave encouraging results.

Observations taken since May 1937 on the migration of woolly aphis in the Chaubattia orchards in the UNITED PROVINCES indicate that migration from underground to above-ground portions of the tree and *vice versa* takes place all the year round, these movements being very slight during winter. The relative susceptibility of various stocks to the pest has been studied and Merton types 779, 793 and the wild apple *Pyrus baccata* are found to be highly resistant. For the control of the pest spraying with soft soap and nicotine sulphate during summer and rosin soap spray containing a little creosote oil or tobacco extract during winter was found most effective.

At the Pomological Station, Coonoor (MADRAS), spraying with nicotine sulphate at one oz. in five gallons of water was found to be unsuccessful in the control of woolly aphis.

In BALUCHISTAN, the seasonal occurrence and life-histories of some of the serious fruit pests, e.g. the codling moth (*Cydia pomonella* Linn.), the bud moth (*Spilonota ocellana* Schiff.), the cherry tip borer (*Quettania coeruleipennis* Schwarzer) and green aphid (*Myzus persicae* Sulz.) of peach, were under investigation. Tests carried out with mineral oils, miscible oils, nicotine sulphate and lead arsenate for the control of codling moth and o ner apple pests showed that lead arsenate was most effective.

At the Fruit Experimental Station, Chaubattia (UNITED PROVINCES), studies on incidence of *Lophosternus hugeli* Redt. on apple trees made in the last four years (1936-39) in relation to the soil conditions show that 74 per cent of

F 2

the borer-attacked trees are growing on sandy soils, 14 per cent on loamy soils and 12 per cent on clay soils. Further it is reported that 20 to 40 per cent of soil moisture is most suitable for egg laying, hatching and survival of young grubs. The larval stage generally lasts for four years. The freshly hatched grubs feed on all kinds of organic matter excepting farmyard manure, leaf mould and well decomposed orchard vegetation, all of which produce a toxic effect on young grubs. This indicates the usefulness of the well-rotted manure for planting young apples. Para-dichlorobenzene mixed in the ground 3 in. deep at the rate of one ounce per running foot killed young grubs up to 6 inches on all sides, while carbon bisulphide mixed in the same way remained effective up to three inches all round.

In the BOMBAY Province there are three species of *Idiocerus* of which *I. niveosparsus* Leth. is most serious in Gujarat, *I. clypealis* Leth. in Ratnagiri district and *I. atkinsoni* Leth. comes into prominence only during the monsoon season when the other two are practically absent. Of these species, *I. clypealis* is most susceptible to the action of sulphur and therefore sulphur dusting resulted in marked success in Ratnagiri district. The other two are resistant to the effect of sulphur, therefore repeated dustings are necessary against them to achieve good results. Sulphur cyanogas mixtures (6 : 1) did not yield results of any marked advantage.

Regarding the control of the coconut beetle, *Orycetes rhinoceros* L. in the MADRAS Province, it was found that systematic removal of beetles from trees and sanding of beetle holes reduced the intensity of the pest. Experiments on the behaviour of the green muscardine fungus which is parasitic on the beetle grubs were in progress.

In MYSORE, a serious infestation of *Oxyptilus regulus* Meyr. caterpillars occurred in vineyards at Hessarghatta. Dusting with pyrethrum powder prevented the pest from boring into the berries.

In TRAVANCORE, biological control of the coconut leaf-roller, *Nephantis serinopa* Meyr. by a Eulophid parasite was tried on a large scale with success.

In BENGAL, the weevil, *Eugnamptus marginatus* Pasc., which damages tender leaves of mango, was kept under control by spraying with lemon chrome. Fruits of pomegranate were protected against *Virachola isocrates* Fb. by enclosing them in muslin bags. *Phyllocnistis citrella* Stainton mining tender leaves of pomelo, orange, etc. was controlled by spraying foliage with Whiz.

Vegetables. In the laboratory of the Imperial Entomologist at NEW DELHI, the marantus borer, *Lixus truncatulus* (F.), and its parasites were studied in detail. The weevil lays its eggs singly in tender branches, the maximum number by a single female being 174 during her life of about five months. The egg, larval and pupal stages during spring last about 10 days, 40—45 days and 3 weeks respectively. Bionomics and morphology of the borer and its five egg parasites, viz. *Pareuderus torymoides* Ferr., two species of *Anastatus*, *Telenomus javensis* Dodd and *Lestodiplosis* sp., one larval parasite (*Dinarmus sauteri* Masi), and one pupal parasite (*Eurytoma curculionum* Meyr.), have also been studied.

At Poona in the BOMBAY Province, field scale experiments were conducted to test the efficacy of tobacco extracts against pea aphis. The chief conclusions were that the pest must be treated from the very beginning and 5—7 sprayings given at an interval of about a week. The insect has the habit of enclosing

itself in between the tender leaves of the growing point which must be thoroughly wetted.

At Coimbatore in the MADRAS Province, the life-history and habits of *Noorda moringae* Tams, a pest of *moringa,* were studied. One generation was completed in 19-28 days, the egg, larval and pupal periods being 3-4, 8-16 and 6-9 days respectively. Caterpillars feed on well-developed buds. The incidence of the pest was generally high from April to August and relatively low during September to December, being minimum in January. As the caterpillars pupate underground, raking the soil around the trees was found to be effective in exposing and killing the pupae.

Tobacco and sulphur dustings were tried at Coimbatore as before against the chillies thrip, *Scritothrips dorsalis* Hood, in two rounds, viz. 84 and 109 days after the planting date of crop. The dusts were found to be so easily washed away with rains that no significant increase in yield was noticed as a result of the treatment. Late dusting of sulphur proved injurious and depressed the yield by about 15·5 per cent.

In TRAVANCORE, a serious outbreak of chillies thrip was controlled by a timely spray of tobacco decoction.

In BENGAL, the diamond-back moth, *Plutella maculipennis* Curt., did serious damage to young cauliflower plants. Its habits were studied and the pest controlled with a spray consisting of lemon chrome 2 oz., Clensel 4 oz. and water 4 gallons.

On account of the late receding of high floods in Bengal, sowing of several *rabi* crops, such as potato, mustard, etc. was delayed, which crops consequently suffered heavily from an outbreak of cutworms (*Agrotis* spp.). Irrigation of affected areas and isolating the unaffected areas from attacked ones by digging trenches proved useful.

In ASSAM, the Chrysomelid beetle, *Pagria signata* Motsch., a pest of cow-pea and some other vegetables was under study. It was controlled by spraying with kerosene emulsion.

Tobacco. The tobacco leaf-curl disease, hitherto known from north BIHAR and certain parts of the UNITED PROVINCES, was observed in Sakrand (SIND) by the Imperial Entomologist and later some specimens of diseased plants were also received by him from BARODA. Thus it appears that the leaf-curl is fairly widely distributed in the Indo-Gangetic region. As a result of numerous experiments carried out at the Botanical Station at PUSA by the Imperial Entomologist, it has now been confirmed that white fly, *Bemisia gossypiperda* M. & L., is the most important vector of this disease in north Bihar, that sunn-hemp and *Ageratum conyzoides* are important alternate hosts of the leaf-curl virus, and that the white fly can easily transmit the disease from the alternate hosts to tobacco and *vice versa*. White fly can also transmit the disease from several other plants to tobacco. The bionomics of the white-fly, its life and seasonal histories and its incidence at different times of the year have been studied. Some preliminary spraying and dusting experiments have been carried out to control the vector.

In MADRAS, studies on the caterpillar pest of tobacco nurseries (*Laphygma exigua* Hb.) were made at Chirala. Trials of growing *ragi* (*Eleusine coracana*) as a trap crop gave encouraging results. Collection of egg masses from the *ragi* edges and the pulling out of the infested *ragi* seedlings and substituting

them by fresh sowings at five days interval resulted in considerable reduction of the pest.

Phthorimaea heliopa Low. appeared in a serious form in nurseries in several estates of the Mysore Tobacco Company. The Department of Agriculture, MYSORE, promptly controlled the pest by spraying with calcium arsenate, collection of infested seedlings and killing the caterpillars by splitting the galls open. Dusting the nurseries with pyrethrum powder mixed with wood ashes also gave good results.

Oil-seeds. In the Entomological laboratory of the Imperial Agricultural Research Institute at NEW DELHI, a new larval parasite, *Systasis dasyneurae* Mani, of the linseed midge, *Dasyneura lini* Barnes, was discovered and its life-history studied. Eggs are laid singly inside unopened flower-buds containing well-developed larvae of the midge. At 18° C., the egg, larval and pupal periods lasted 2—3, 12—15 and 11—14 days respectively.

The Imperial Entomologist observed a new fruit fly pest on safflower in the experimental plots of the Imperial Economic Botanist at NEW DELHI. The fly proved to be *Acanthiophilus helianthi* Rossi, both the genus and the species being recorded from India for the first time. The fly lays eggs in the floral buds and the maggots feed on the florets or even bore into the thalamus. The infested buds rot and subsequently fall off. Some varieties, especially Nos. 30 and 34, were found infested to the extent of 50 and 62 per cent respectively.

The life and seasonal histories of *Stomopteryx nerteria* Meyr., a serious pest of groundnuts in South India, were studied at COIMBATORE. The total life-cycle of the insect takes 21-24 days. The maximum longevity of adults when fed was 35 days but without food they did not live for more than four days. The incidence of the pest varied between 5·8 and 14·2 per cent. Light trap trials showed that moths were attracted to light throughout the night and Petromax lamp gave bigger catches than the ordinary hurricane lantern.

The earwig, *Anisolabis annulipes* Luc., was noted for the first time as a pest of groundnut at Coimbatore. Its life-cycle varied from 42 to 71 days, the egg and nymphal periods being 7—11 and 35—60 days respectively.

Cardamom. At Coimbatore in the MADRAS Province, experiments were started to assess the damage done by *Taeniothrips cardamomi* Ramakrishna and to devise methods for its control. In some of the estates in the Anamalais, 60 per cent of the pods are damaged. Besides the direct damage, the thrip is believed to be a vector of the cardamom mosaic or warble disease. However, experimental transmission of disease by the thrip has not yet been proved.

At the Coffee Experimental Station in MYSORE, the cardamom thrip (*Taeniothrips cardamomi*) causes blister-like corrugations on fruits and was studied from control point of view. Dusting with pyrethrum and sulphur gave encouraging results.

In TRAVANCORE, the thrip was effectively controlled with tobacco decoction prepared at the rate of one pound of tobacco waste in 15 gallons of water.

In MYSORE, the hairy caterpillar, *Eupterote canaraica* Moore, appeared as a serious pest after about 15 years. The full-grown caterpillars pupate on the mass of excreta and soil below the tree trunks in large numbers. They can be thus easily collected and destroyed. Caterpillars are also killed in large numbers by a fungus enemy during north-east monsoon rains. Moths emerge about six months after the date of pupation.

In TRAVANCORE, the hairy caterpillar is often serious in cardamom estates. Of the various insecticides tested, fish-oil soap was found to be most effective and economical when used at one pound in 5 gallons of water. Its use was demonstrated over 90 acres and was widely adopted.

Coffee. Experiments were in progress at the Balehonnur Coffee Experiment Station in MYSORE to ascertain the efficacy of several proprietary ovicidal stem-washes which could be utilized to prevent the spread of the coffee stem-borer, *Xylotrechus quadripes* Chevr. The results, although inconclusive, show that winter Whiz may prove to be a promising insecticide.

As a result of the Pest Act enforced in the coffee-growing regions of Hassan and Kadur districts in MYSORE, a total of about 33 lakhs of borer-affected plants were uprooted and destroyed and another one and a half lakhs of such plants were destroyed as a result of 426 notices issued to unwilling planters. Further, in 12 places 66,034 diseased plants were got removed by the Department of Agriculture, MYSORE.

Observations on the egg-laying and other habits of coffee borer beetles emerging during summer months were made at Chikanahalli and neighbouring estates in MYSORE.

An intensive study of *Xyleborus morstatti* Hag., the shot-hole borer of coffee, is also being made at Chikanahalli and other estates in MYSORE. Two alternate host plants, viz. *Crotalaria* sp. and *Clerodendron* sp., have been found to harbour this insect during the period of four to five summer months when they do not breed on coffee twigs. Prompt removal and destruction of infested coffee twigs and *Crotalaria* and *Clerodendron* plants by burning them during summer has been suggested as a measure of control.

Tea. Tbe TEA SCIENTIFIC DEPARTMENT of the UNITED PLANTERS ASSOCIATION of Sonth India reports that termites (*Kalotermes* sp.) have been a source of immense trouble to living tea bushes, especially in the Anamallais.

The grasshopper, *Orthacris incongruens* Carl. was serious in an estate in the Nilgiris. Its egg-laying habits were observed. Large percentage of hoppers were found infected with the maggots of a parasitic fly. The usual poison-bait consisting of bran, paris green and molasses did not prove effective. Cut-worms were reported as attacking very young tea plants.

Xyleborus fornicatus Eich., hitherto confined to central TRAVANCORE, was noticed for the first time on an estate in south TRAVANCORE.

The red coffee borer (*Zeuzdra coffeae* Nietn) was reported attacking tea plants from the Anamallais and the High Range. Its attack is felt severely only on young plants. Cutting off of the attacked branches and destruction of the borers or injection of carbon bisulphide or petrol into the borer holes are recommended as control measures.

Stored grain pests. In the PUNJAB, observations were made on the phototropic responses of *Trogoderma khapra*. Majority of freshly hatched grubs were unaffected by light but as they advanced in age they became photo-negative, this reaction being maximum in the fourth instar. Female adults during the oviposition period and majority of males behaved photo-negatively.

In the MADRAS Province, experiments were carried out on the preservation of paddy and *cholam* against *Calandra oryzae* L. and *Rhizopertha dominica* F. by mixing the grains with various insecticides, e.g. acorns powder, pyrethrum, derris lime and creosote, *neem* leaves, *tulsi* leaves and talc powder. The results

were compared with those obtained by monthly sun-drying of grains. It was found that sun-drying was better than other methods. Of the preservatives, white lime and creosote mixture, paracide and acorns yielded promising results.

7. Useful insects

Lac and shellac

Good *Baisakhi* and fair *Katki* yields were obtained from *Albizzia lucida*, *Ougeinia dalbergiodes* and *Ficus cunea*. Infections of *Acacia catechu* with *Butea frondosa* and *Zizyphus jujuba* brood for the *Katki* crop gave good results, indicating that *A. catechu* can be used as a *Katki* host as well as for the *Aghani* crop.

The Pentatomid *Tessaratoma javanica* again appeared as a serious pest of *Schleichera trijuga*, it was controlled by an Eupelmid egg parasite, *Anastatus colemani*, not previously reported from India and by hand picking.

Methods of mass breeding of *Microbracon greeni* parasitic on the lac predator *Eublemma amabilis* and of *M. greeni* parasitic on the lac predators *E. amabilis* and *Holcocera pulverea* were improved during the year. Research indicates that periodic releases of *M. greeni* at critical times would yield beneficial results. A number of releases of *M. hebetor* were made in two areas; in both evidence of colonization by this species were observed. A scheme has been drawn up and an area selected in which to test out on a field scale the practicability of these two species in the biological control of lac predators.

Two Trichogrammid egg parasites of *E. amabilis* and *H. pulverea* *Trichogrammatoidea nana* and *Trichogramma minutum*—received special attentions. Methods of laboratory rearing were devised on both the eggs of lac predators and of those of alternative species. The potential value in control of these species has been shown to be great.

Considerable work was carried out on the constitution of shellac and halogenation, hydrogenation, fractionation with alkali and the action of urea were some of the methods tested which have provided useful information on the nature of shellac and its constituents.

Further efforts on the modification of shellac into resins having better properties than the natural shellac have resulted in the possibility of obtaining a new resin by the action of formaldehyde and urea on shellac, which not only gives a good, short-baking varnish, but is also eminently suitable for moulding. Articles prepared out of this resin and wood-flour as filler have greater heat stability and water resistance than pure shellac mouldings.

It has been found possible to prepare economically a good, black, baking varnish by distilling shellac or lac refuse with lime and treating the distillate with sulphur and linseed oil. The varnish will be a satisfactory substitute for imported, black stoving enamels for coating metal surfaces and the process has also indicated a good method of reclaiming and utilizing aged and partly perished lacs.

A possibility has been found of using aluminium discs coated with shellac or shellac-nitrocellulose lacquers for preparing home-recording sound discs and unbreakable gramophone records, but the economical aspects of the process and the effect of the latter on the consumption of lac are waiting to be studied.

Indications are obtained of the possibility of preparing shellac lacquers

containing a proportion of nitrocellulose suitable for spraying in order to replace imported, costly finishes. Comparative tests will be arranged outside and if these finishes are found suitable, they would find an application in high-class finishing work like the painting of motor car bodies.

Considerable progress has been made in the commercial possibilities of shellac moulding by working in close cooperation with one or two interested moulding concerns. With the discovery of the modified shellac moulding powder and from the interest taken by these commercial, bakelite-mounding concerns, great bopes are entertained of the possibility of starting shellac-moulding industries in this country in the near future.

CHAPTER VI

AGRICULTURAL MARKETING*

THE Royal Commission on Agriculture, reporting in 1928, had stressed the great importance of improvement in agricultural marketing in India. Accordingly the office of the Agricultural Marketing Adviser with a central staff was established by the Government of India in 1935 and in order that the all-India commodity surveys might be carried out on an uniform basis, the Imperial Council of Agricultural Research made grants spread over a period of five years to provinces to meet a part of the cost of provincial marketing staffs. The cooperation from the autonomous provinces and states was spontaneous. Each of the major provincial Governments had from the very outset provided, at its own cost, a Provincial Marketing Officer to take charge of the work. They, in some cases, further added to their staff to meet the demand for development work of a practical nature. Ten leading Indian states have engaged full time marketing officers and in addition over 200 States have nominated persons to carry on marketing enquiries so that marketing work is now receiving attention throughout the whole of India.

In earlier years most of the time and attention of the marketing staffs was devoted to investigation work connected with the preparation of the marketing survey reports. During 1938-39, apart from the continuation of this work, steps were taken to give practical effect to the recommendations arising out of the surveys already completed and all-India reports on linseed, eggs and tobacco were published. The grape report and the abridged editions in Indian languages of the linseed report were in the press and survey work was completed and reports were being compiled in respect of rice, groundnuts, coffee, potatoes, milk, cattle, hides and skins and cooperative marketing. Twenty-one other commodities were under survey and altogether over 300 commodity survey reports received from provinces and states were being scrutinized for preparation of all-India reports.

The general policy of concentrating on development work of immediate practical value was continued with increased vigour. The grading of ghee, eggs and fruits spread rapidly and the systematic grading of *ata* and rice was commenced at several centres. As a preliminary to the grading of coffee, citrus fruit products, edible oils and *vanaspati*, draft specifications for these were drawn up as a result of discussions at the informal conferences convened by the Agricultural Marketing Adviser to the Government of India. The year was also notable for the increasing interest taken by certain provincial Governments in the scheme.

Up to the end of March 1939, the number of grading stations were as follows:

Eggs 36, hides 10, *ata* 2, tobacco 3, fruits 27, ghee 53 and rice 3.

* The assistance of Mr. A. M. Livingstone, C.I.E., M.C., B.Sc., Agricultural Marketing Adviser to the Government of India, in the preparation of this Chapter is gratefully acknowledged.

The results obtained at these stations showed that there was in fact in India a good demand among consumers for reliable high-grade produce for which producers could secure a substantial premium. In some cases the AGMARK products fetched 50 per cent more than similar produce ungraded and the average increase ranged from 5 per cent in the case of eggs to 11 per cent for fruits and 8 per cent in the case of ghee. That grading was appreciated even in markets outside India was revealed by the regular premium fetched by the graded rice exported from Kuttalam (Madras) to Ceylon.

Ghee grading proved most popular and at the same time presented the most complicated problem. The possibility of skilful adulteration and fraudulent use of the AGMARK had to be guarded against by devising a system of checks and counter checks which required considerable administrative alertness as well as technical skill. Instructions detailing the nature of equipment, staff and work at the merchants' laboratories were drawn up in an easily intelligible manner and it was arranged to check up the merchant's grading by analysing a few samples of AGMARK ghee collected from the open markets at random. The Central Ghee Control Laboratory at Cawnpore was responsible for the whole analytical work in this connection.

As mentioned in last year's review, ghee produced in certain areas such as Kathiawar, though genuine, failed to conform to the all-India standards. The problem was thoroughly investigated and special standards were drawn up to suit these areas. The states of Porbandar and Nawanagar thereafter started ghee grading under the control of special state laboratories equipped for the purpose. BARODA was another important state to enter into the ghee-grading scheme.

Ghee-grading presented further difficulties in that the all-India standards prescribed by the Agricultural Marketing Adviser came into conflict with local standards laid down under the provincial pure food laws. In Sind some AGMARK ghee distributors were also prosecuted for adulteration as the product did not conform to local standards. Similar difficulties were also met with in Madras and the Punjab. Hence, with a view to securing uniformity in the provincial pure food laws, the whole matter was placed before a special *ad hoc* committee of the Central Advisory Board of Health.

In spite of these difficulties, the ghee-grading scheme became increasingly popular and several states such as Patiala, Gwalior, etc., expressed their desire to take up the work and also made the necessary laboratory arrangements. The advantages of the scheme were increasingly evident to the packers who agreed to pay a small charge for the labels supplied by the Agricultural Marketing Adviser. It is hoped that in the course of a few years the whole expenditure on account of quality control will be borne by the trade.

Next in importance as well as in popularity came egg grading which was spread over the whole of India. Grading was done mostly with the help of small hand-grading machines. The work was satisfactory and the Government of Bengal itself established three centres. It was realized from the very beginning that grading to be really effective should be followed up by attempts at improving the packing and transport of eggs and accordingly an improved type of light container was designed and tried. It is hoped that it will be possible to standardize an improved type of light, returnable container which

can be adopted by the trade generally. Similar experiments were also conducted in connection with suitable containers for fruits.

Although the tanners and hide merchants continued to maintain an attitnde of merely passive support, the Government of the United Provinces and Bengal took over the hide grading stations in their areas. A peripatetic grading demonstration party was also introduced in the United Provinces with the object of educating flayers in rural areas in the methods of grading. They were taught at the same time proper methods of flaying.

In order to ensure adequate control of quality and proper grading, several persons in the provinces and states were authorised by the Agricultural Marketing Adviser to inspect graded produce and grading centres. The cooperation of Agricultural, Veterinary, Cooperative and allied Departments in all provinces was sought in this connection and several of their officers were provided with the necessary authorization. It is gratifying to note that so far the grading stations have been functioning satisfactorily and there has been no instance of deliberate and improper marking of produce.

Apart from these grading activities, attempts to draw up standard contracts for the heavy staples such as wheat, linseed and groundnuts were brought to a successful conclusion when suitable contract terms were settled as a result of discussions at informal conferences held during the year. The uniform adoption by the trade of these contracts was, however, rendered difficult by the stiff opposition of a minority of traders and the possibility of putting the contracts on a statutory basis was discussed with the members of the trade at two meetings held at Calcutta and Bombay under the Chairmanship of respective Ministers of Agriculture. The question is still under consideration.

In consultation with provincial Governments and trade interests concerned steps were taken to add more commodities in the Schedule to the Agricultural Produce (Grading and Marking) Act, which, by March 1939, included fruits, vegetables, eggs, dairy produce, tobacco, coffee, hides and skins, fruit products, *ata*, oilseeds, vegetable oils (including hydrogenated oils and vegetable fats), cotton and rice. Rules in respect of most of the new commodities had been framed. Certain Indian states, viz. Porbandar, Nawanagar and Patiala had enacted legislation on the lines of the Act and Bills were under consideration in the States of Gwalior, Mysore and Baroda. The question of adoption of the Act and the Rules was also under consideration in Kashmir, Travancore and Junagadh.

It will be appreciated that grading alone will be valueless if, side by side, steps were not taken to improve the actual conditions of marketing. The necessity for well-regulated markets for all produce was stressed by the Royal Commission on Agriculture which recommended that all provincial Governments should take the initiative in establishing regulated markets under provincial legislation. To ensure a certain degree of uniformity in legislation the Central Marketing Staff circulated a model bill and before the end of March 1939, an Act for the regulation of markets had been passed in the Punjab. Bills suitable for local conditions had been introduced or prepared in the United Provinces, Bihar, Bengal and were under preparation in Sind, the North-West Frontier Province, Mysore and Travancore. The Bombay Act was being extended to include produce other than cotton and in Madras the Commercial Crops Markets Act was extended to tobacco in the Guntur area and ground-

nuts in South Arcot district. Statutory regulation of markets already prevailed in the Central Provinces, and in certain states such as Hyderabad, Gawalior and Patiala. It will thus be seen that as soon as the recent legislation, either passed or contemplated, is put into effect, this recommendation of the Commission will be well on the way to fulfilment throughont the greater part of India.

These attempts at regulation of markets were fittingly strengthened and supplemented by the passage on the 28th March 1939 by the Central Government of the Standards of Weight Act, 1939, which laid down the tola, the seer and the maund and the pound, the ounce, the hundredweight and the ton, as the standards to be generally adopted in India. The marketing survey reports had clearly described the chaotic conditions prevailing in this connection and had strongly advocated the immediate adoption of the necessary legislation. The Act will be brought into force as soon as the necessary rules have been framed and arrangements for the preparation of sets of standard weights made. Pending the passing of central legislation, proposals were awaiting consideration in most of the provinces. Bills to standardize their weights on the basis of the all-India standards were also taken in hand in Hyderabad, Patiala and Travancore, and Mysore had indicated a readiness to follow suit. It is, therefore, reasonable to suppose that uniform standards of weight will be established throughout most of India in the very near future.

During the year the broadcast from Delhi of daily Hapur market quotations and the weekly market report dealing with prices, stocks and movements of wheat, linseed and rice was continued. Steps were taken to make the weekly market report more comprehensive and to give it wider publicity through newspapers and journals. The Calcutta prices of jute bags were sent to the all-India Radio, Delhi, for broadcasting twice a week. A market news service regarding milch cattle was established between the terminal market, Bombay and certain despatching markets, viz. Rohtak, Bahadurgarh and Delhi on a reciprocal basis. Arrangements were also in hand for extending this news service on similar lines between Rohtak and Calcutta and Mehsana (Baroda State) and Bombay.

As usual, efforts were made to keep the public informed of the activities of the marketing staffs by taking advantage of the various agricultural exhibitions in the provinces and states. Public demonstrations were given of the technique of grading by exhibiting illustrative maps, diagrams and charts, relating to the production, supplies, prices and distribution of various agricultural commodities together with grade discs, labels and grading apparatus.

Though the progress outlined above is considerable, it is realized that only the fringe of the problem has been touched so far. Persistent and patient efforts spread over a considerable period will be necessary to achieve results on a wide scale. It is for provincial Governments to follow up the initial success achieved. It is encouraging to note that the Conference of Ministers on Agricultural Marketing which was convened by the Government of India in November 1938 to review the progress made so far not only recognized the value of the results obtained but also recommended to the Government of India and to the provinces and states the necessity for the continuation of the scheme. It is to be hoped that the provinces and states concerned will take action accordingly, and provide their marketing staffs with the necessary men and money for pursuing their activities with redoubled vigour.

CHAPTER VII

AGRICULTURAL ENGINEERING*

Boring and pumping

IN the BOMBAY province, nine boring machines (eight 6-in. Calyx rotary drills and one 4-in. Musto percussive power boring machine), nine pumps and five pumping plants were given on hire, 23 pumping plants were erected and 111 private plants were inspected through mechanical assistants in the divisions. Similarly 33 plants were repaired, 25 new sites were surveyed and 35 estimates were supplied for power plants of different nature. The receipts for hire of plants and for the sale of spares and machines amounted to Rs. 7,385 and Rs. 2,927 respectively.

In the MADRAS province, 121 boring sets (14 Armstrong power drills, 1 Compressor drill and 106 Hand-boring sets) were maintained and the total number of borings put down and the depth bored during the year amounted to 759 and 58,248 feet respectively, as against 971 and 69,840 feet respectively in the previous year. Ont of 759 borings made during the year, 612 were found to be successful. In addition to the total number of boring machines given above, 15 more boring sets were manufactured before the close of the year. The demand for boring is very great and more sets will be necessary. The amount spent on boring operations, by the users of the departmental sets, during the year is estimated at Rs. 1,72,049. Of the 759 borings put down, those for agricultural purposes numbered 340. The deepest of the borings completed during the year by hand-boring set was 583 ft. 6 in. and that by a power drill was 896 ft.

During the year 26 new artesian springs were tapped, thus making a total of 176 including those tapped before. Out of these, 15 in the Godavari district are capable of discharging fresh water at the rate of 5 to 350 gallons per minute at ground level and the remaining 11 are able to supply good water at varying rates from 1 to 600 gallons per minute, the height of discharge ranging from 1 to 12 ft. Special mention must be made about an artesian boring tapped in Ramachandrapuram taluk which is giving a discharge of 350 gallons per minute at ground level and has helped to bring under cultivation a further area of 15 acres, yielding an increased income of Rs. 1,500 a year.

Out of the nnmber of sub-artesian borings put down at various places in the province, 23 bores were made in places notorious for scarcity of fresh water even for drinking purposes, and almost all of them, with the exception of only two, were successful. Power drills were used for making 11 bore holes and almost all of them are giving good supply of water.

The torpedoing operations were conducted in 16 bore holes in order to increase the water supply and the result was satisfactory in many of them.

The Department maintained 22 pumping sets for hiring to cultivators to pump water for their crops during periods of drought and for sinking wells.

* The assistance of Rao Bahadur C. G. Paranjpe, Agricultural Engineer to Government, Bombay, in the preparation of this Chapter is gratefully acknowledged.

The number of new applications for advice was 257, out of which 251 were disposed of during the year and 53 pumping plants were erected. The new area brought under cultivation on account of pump irrigation comes to 58½ acres with an income of about Rs. 3,850 a year. The receipts during the year on boring and pumping amount to Rs. 63,949.

In the UNITED PROVINCES, 352 projects consisting of 36 tube-wells of 5 in. and over in diameter and 314 tube-wells of 3⅜ in. in diameter were completed. There has been a decline in the number of large tube-wells constructed due to the fact that the saturation point has been reached in several districts due to the construction of State tnbe-wells. The development of water supply from artesian wells in Tarai and Bhabar areas has been an outstanding work of the year as more than 30 such wells have been constructed to supply water not only for irrigation but also for drinking purposes.

The total number of large tube-wells so far constructed amounts to 1,025 and that for smaller tube-wells 3⅜ in. in diameter comes to 2,541 since 1924.

Assuming an area of 100 acres for each large tube-well and 25 acres for a smaller one, the total acreage brought under command by both the types of wells comes to 1,65,000 acres. A number of existing masonry wells were bored to augment their supply of water and the total footage bored in these wells, during the year, amounts to 1,35,981 ft. The percentage of success in these cases has risen from 86·8 to 88 and the cost to Government has been reduced from Rs. 38-8-11 to Rs. 37 per well bored.

Considerable progress has been made in the improvement of supplies of well-water under the rural development scheme, and 458 wells have been bored according to this scheme, out of which 432 wells have been found to give increased water supply.

In the PUNJAB, 49 boring sets were at work and augmentation snpply tubes were sunk in 427 open percolation wells, out of which 348 were successful. The total footage bored was 45,200 ft. against 38,000 ft. in the previous year. Strainers were inserted in 159 of the successfully bored wells. The average yield of water from the successful bores increased from 900 gallons per hour before boring to 3,000 gallons per hour after boring, under an average depression head of 3 ft. The average length of strainers used is 17 ft. per well and 88 per cent of them are of the new slotted pottery type. Cadmium-plated strainers were used in most of the remaining bores. The latter type of strainers is more in demand in tube-wells larger than 3½ in. in diameter by reason of its robustness, efficient service, comparatively low initial cost and immunity from the action of alkali salts in the sub-soil water. Seven trial bores were sunk in five districts with a view to collecting data on the waterbearing qualities of the sub-soil in those localities. Seventeen power operated tube-wells were completed and handed over to their owners. The average depth of boring and the average length of the strainers per well in these cases were 296 ft. and 80 ft. respectively.

The most important amongst tube-well sinking operations of the Department is the Irrigation Branch project at Karol near Lahore, where the sinking of 31 tube-wells of 18 in. diameter has been undertaken and five such wells have been completed, tested and handed over before the end of the year under report.

In ORISSA, the total number of borings done during the year was 10, out of which 7 were successful. The post of a well-boring supervisor was created during the year to supervise the boring work.

In the CENTRAL PROVINCES, a six-in. bore is being made in hard trap which reached a depth of 100 ft. by the end of the year.

In the MYSORE State, two direct driven pumping sets, consisting of 10 h.p. electric motors and 2½ in. centrifugal Kirloskar pumps with a long pipe line and pump houses were erected at one of the State farms.

Agricultural implements and machinery.

In the BOMBAY province, further experiments in connection with the improved drill, with the exception of the special wheat-drill, have been discontinued as it has now come to such a stage that further radical improvements in its design appear to be impossible especially when its cost and draft are to be kept within a certain limit.

In all 23 improved seed-drills were so far made and supplied to departmental institutions and outsiders. The recent improved models have practically fulfilled all the stipulated conditions, both as regards draught and quality of work. There are, however, a few drawbacks in the machine, that it cannot be worked when the soil is wet or where there is slight drizzling rain, such defects cannot, however, be remedied with a wheeled machine without interfering with its cost and draft. Its advantages such as automatic and uniform sowing, reduced draft, adjustment in depth and seed-rate, saving in seed, etc. have been, however, fully appreciated.

Further improvements have been effected in the soil scooper to suit the peculiar soil conditions at Bijapur and recent trials have proved that it can successfully deal with this type of soil with the modifications made.

The winnowing fans have become very popular with cultivators and the demand for them is gradually on the increase. During the year 15 new fans have been prepared and supplied, thus making up the total number to 33. Experiments to improve it still further are in progress.

In all 12 sets of cart wheels have been fitted with ball bearings and supplied to different parties during the year, which makes up the total number to 35. The introduction of ball bearings in ordinary cart wheels has been greatly appreciated on account of the ease in working, saving in lubrication, reduction in draught, etc.

Out of the three groundnut diggers made and supplied for tests, the two sent to Gokak and Karad respectively were found to work quite satisfactorily. The third one sent to Madha in Sholapur district did not work so well on account of the soil being very stiff and cracked. A stronger machine appears to be necessary for such tracts and experiments in that connection are in progress.

In the MADRAS Province, 6,608 new ploughs were sold during the year as against 5,257 ploughs sold during the previous year. The increase in the sale of the ploughs and the demand for the supply of their spare parts indicate that the conservative ryots do not hesitate to go in for better implements. Some ploughs manufactured by a local firm are now undergoing field trials at different research stations to determine the wearing qualities and durability of the different parts.

Of the ploughs approved by the Agricultural Department, Cooper No. 11 continued to be most popular and the next in demand are the small Cooper No. 25 and Gurjar No. 2. The demand for bigger ploughs is slowly increasing

and the new Cooper No. 34, the sale of which has risen up to 122 during the year, may be said to have completely replaced the Victory plough, which is considered to be the best of its kind amongst the imported implements from foreign countries.

The bar point ploughs supplied by Messrs Cooper Engineering Works, Ltd., Satara, are being tested. The small size ridge plough, designed by the Agricultural Research Engineer, has been gaining popularity, and 257 such ploughs were sold during the year. Another ridge plough with adjustable wings to make furrows of different width and a cultivator to replace the foreign cultivator, have also been designed by the Agricultural Research Eugineer and are under final tests. The *bund*-former designed by the engineering section is being used even in provinces outside Madras for demonstration and their demand is met by local manufacturers. The defects noticed last year in the bullock-drawn basin lister (single furrower) were rectified by altering it to a double furrower to give even draught, and it is under trial in different black soil areas. A stubble-gathering implement has been designed for collecting stones and stubbles in the fields after tbe harvest of the crop and is under trial. Similarly the digging forks made by a local firm are much cheaper than foreign ones, which are also under trial in the potato-growing areas in the Nilgiris. Further improvements were made in the new mechanical seed-drill designed by the research engineering section to make it cheaper and lighter, consistent with efficiency. It can be used for sowing any kind of seed at any depth and width. Its only defect is that it is a little costly. Further work on the green manure trampler has resulted in the production of a simple and light implement useful for incorporating green manure into puddled fields and can be easily worked by an ordinary pair of work animals. Considerable attention was paid during the year to the improvement of the wet land puddling implement by making it lighter in draught and reducing its cost. The turmeric polisher designed by one of the agricultural demonstrators has become popular in the turmeric areas. It is proposed that the same machine may be made useful for polishing ginger and experiments in that direction are in progress.

Tests were conducted on a number of paddy-shelling hand-machines with a view to ascertain which of them proves to be the best. The Japanese Oe Co Co machine was found to be very efficient and capable of shelling in a normal day of 8 hours, when worked by two coolies, eight hags of paddy with almost negligible percentage of breakage of rice.

Eight sugarcane mills possessed by the Department were fully engaged during the season and 3,990 tons of cane were crushed. The two sugar centrifugals maintained by the Department were also demonstrated.

A big plant consisting of a steam engine, two boilers (using groundnut husk as fuel) 18 double roller gins, three groundnut decorticators, two seed-cleaning machines, was installed for a private individual in Hospet taluka. An improved type of paddy-husking machine, which was constructed by the section of the Industrial Engineer, was under test at the close of the year.

In the United Provinces, cheapness in the manufacture of the Meston plough was demonstrated and a few local firms have been encouraged to undertake its manufacture in large quantities. The ploughs supplied by such firms were tested and suggestions given by the Agricultural Enginee. regarding their manufacture. Similarly local firms have undertaken the manufacture of the

Olpad thresher and Akola hoe which have been standardized by the section. A standard hand chaffcutter, costing about Rs. 25, has been evolved. Similarly a five-tine cultivator, which is in great demand in sugarcane areas, has been produced at a cost of Rs. 14-7 only. A light turn-wrest plough, suitable for hilly tracts where terrace cultivation is in vogue, has been manufactured and tested with satisfactory results. A *bund*-making *karha* has been devised and standardized at a cost of about Rs. 20. As a larger plough than the Meston is a necessity in western districts, attempts to evolve such a plough have been successful and the result is the victory plough costing about Rs. 23. Improvements in the Meston plough have been undertaken. A few winnowing machines have been manufactured and the price has been brought down to Rs. 100. A cheap type of 3-tine seed-drill for later crops is under test. Proposals for an implement testing station have been approved and a site has been selected for the purpose.

The Engineering Department of the ALLAHABAD AGRICULTURAL INSTITUTE has been engaged in trying to develop agricultural implements such as ploughs, cultivators, harrows and seed-drills and its efforts along this line have been recognized by the provincial Government who have promised to subsidize the Department for the manufacture of such implements for the cultivators in the province.

Three types of improved *bels* (juice-boiling furnaces), one an improvement over the Rohilkhand *bel* and the other two, improvements over the Bilari *bels*, have been designed by the IMPERIAL INSTITUTE OF SUGAR TECHNOLOGY, Cawnpore, at the Sugar Research and Testing Station, Bilari. These improved *bels* have got several distinct advantages over the most common *bels* now in use, such as large increase in juice-boiling capacity, economy and self-sufficiency in fuel consumption, increase in juice-boiling efficiency, etc. A revolving crystallizer, which can be made locally at small cost, is also designed by the same Institute, and it has the following advantages over the present system of using *kalsis* (earthen pots) for storing the concentrated syrup after it is aerated in *nands* :

(*a*) It takes less time for cooling and crystallizing.

(*b*) *Rab* cooled in this crystallizer gives a higher yield of sugar.

(*c*) The quality of sugar is much better, the grains being bigger and more uniform.

(*d*) It does away with the necessity of a pug mill.

(*e*) More *rab* can be centrifuged in the same time with less expenditure of power.

In the PUNJAB, according to the scheme mentioned in last year's report, about 40 entries were received for the design of a bullock-drawn cultivator. Out of these, two designs for the manufacture of full-sized implements were selected, and, after testing them under field conditions, it was decided that the prize of Rs. 3,000 should be divided between the two designs. Of the two models, one is a 5-tined cultivator and the other is a cheap device by which an ordinary *desi Monah* plough can be easily and quickly converted into a cultivator. The final designs for the two implements are now being worked up prior to patenting them. For the coming year a cheap and efficient winnowing machine has been selected for competition.

In BENGAL, the number of improved ploughs distributed during the year came to 581. An improved type of hand hoe has also been produced, of which about 350 are now in the district.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, New Delhi, ploughs of various types from different parts of the country were collected and 15 of them were subjected to preliminary tests on draught when pulled by bullocks with the help of a recording dynamometer. The A. G. B. general cultivator and bullock hoe, which was received back from the makers after incorporating a number of improvements suggested by the Imperial Agriculturist, was found to work satisfactorily and can be now called a perfect implement.

The mechanical seed-drill received from the Research Engineer, Coimbatore, was tested and tried for sowing wheat and was found unsatisfactory, the main defect being that the seed-distributing discs were not revolving freely on account of their getting choked during drilling.

In MYSORE, 100 ploughs at a cheap cost of Rs. 10 each were supplied in the Irwin Canal area and local blacksmiths were trained to produce cheap iron ploughs. An attempt was made to increase the life of worn-out shares by inserting steel points. Trials conducted with such shares have shown that it is possible to enhance the use of a ploughshare by this method.

The improved seed-drill evolved by the section was used to sow *ragi* and *jola* seeds on State farms. It was also demonstrated at various places with a view to making the cultivators appreciate its advantages over the local drill. The departmental power cane-crusher was worked in two private areas where improved furnaces were built and cream jaggery was made. A power thresher of the Industries Department was tried this year also and modified further.

In TRAVANCORE light iron ploughs, like the Climax and the Meston, which suit local conditions have been introduced and blacksmiths have begun to manufacture and sell iron ploughs of similar type. The ryots' scepticism about the ability of local bullocks to draw the iron ploughs is fast disappearing. A Chattanooga iron cane mill installed in a State sugarcane farm has been demonstrated to many sugarcane cultivators during the year and has been found cheap and efficient.

In BARODA, cultivator and hoe, designed by the State Agricultural Department, is in great demand. Among the hand implements, the principal tool is the cotton root-puller which has been intensively advocated as a means to reduce the annual damage caused by the stripped bollworm on cotton.

The improved Olpad thresher has been demonstrated on an intensive scale in wheat tracts during the year. The use of this machine has shown that there is a saving of about Rs. 8 in the cost for threshing 100 md. of grain when compared with the usual local method of threshing.

In COCHIN, most of the implements and tools required for farm use and for sale, such as hand forks, pruning shears, grass-cutting swords, rakes, wheelbarrows, grafting knife, etc. have been made at the State workshops.

Miscellaneous

In BENGAL, attempts have been made to solve the problem of reasonably good manure pits for the various Government farms and the last design is before the Government for approval. Standard plans also have been designed for

bullock sheds and byres for milk cattle. Similarly improved threshing floor has also been evolved. An experiment was carried out in the colonization area of the Bakarganj district in connection with improvement of land and crops in that area. By means of sluice gates and *bunds* a fairly large area was enabled to produce considerably more yield of paddy per acre than what it could do before. Two types of large all-steel trolleys for light and heavy portable pumping plants and two more types of all-steel farm carts with pneumatic wheels were designed and manufactured. Several kinds of small ventilated seed bins were also designed. Drawings and estimates for a large number of buildings and other civil engineering works for the department and other institutions, etc. were prepared and supplied.

In MYSORE, the agricultural engineering section devoted its attention to the preparation of estimates and execution of building schemes, purchasing of mechanical fittings and the management of Government workshops. This section had a busy programme of construction in connection with the expansion of poultry schemes, cream jaggery, activated charcoal plant, etc. The Government workshops completed 342 jobs comprising model fowlhouses, improved fly traps, beehive boxes, honey-extracting appliances, etc.

Plans and estimates, 82 in number, amounting to a total value of Rs. 50,000, were prepared during the year. Work in connection with the development in the rural welfare centre such as the designing of modern manure pits, poultry houses, etc. was also undertaken.

In MADRAS, experiments were carried out on testing the pneumatic tyre equipment for bullock carts under exacting conditions and the results have been favourable. Four carts of varying capacities were also constructed with these tyres during the year. The Industrial Engineer conducted experiments with a view to evolving a process for the recovery of silver from spent hypo used in the photostat process and was successful in evolving a method by which a major portion of silver could be recovered. He also conducted comparative tests on rice mills of various types with a view to minimizing the loss of vitamins in rice and submitted a report to Government for consideration.

The agricultural engineering section took part in the fair exhibitions and all-India Khadi and Swadeshi exhibitions held in Madras and Coimbatore.

Mechanical cultivation

In MYSORE, the old tractor of the Department was worked to plough about 30 acres of fresh land. A scheme for the purchase of two new tractors is before the Government for consideration.

The IMPERIAL AGRICULTURIST, New Delhi, conducted exhaustive tests with two tractors, viz. the W. D. 40 McCormick Deering and the Hanomag 55 h.p. with different implements and collected very useful information regarding the draft by a recording traction dynamometer. The average cost of ploughing over three seasons worked out to Rs. 2-3-8 per acre for the Hanomag and Rs. 1-6-9 per acre for the McCormick Deering.

In the UNITED PROVINCES, the agricultural engineering section has in use only two caterpillar tractors of 40 and 50 horse power respectively. The former ploughed 265 acres, harrowed 664 acres and rolled 133 acres. The other tractor was used in the eradication of *kans* in Bundelkhand. It has been

noticed that it is possible, on an average, to plough about 500 acres per year per tractor of this size.

In BOMBAY, the Agricultural Department ploughed 317 acres of sugarcane fields with two different makes of tractors in connection with the prevention of grasshoppers scheme.

Progress in implementing the recommendations of the Royal Commission on Agriculture

Almost all provinces and states have done some work on agricultural implements and machinery, Madras being the foremost, presumably because of the appointment of a special officer for research.

With regard to pumping and boring, Bombay, the Punjab, Madras, the United Provinces, Orissa, the Central Provinces and Mysore were active in this respect. Three provinces, viz. the Punjab, Madras and the United Provinces, however, have done considerable work both as regards boring and pumping. Madras has to its credit 26 artesian wells and 759 bores, while the United Provinces have 350 tube-wells and 432 ordinary bored wells, whose supply has been increased by boring. The Punjab has done 427 bores and 5 large tube-wells of 18 in. diameter. The United Provinces stand first in footage bored, while Madras stands second and the Punjab third. Madras has in addition maintained 22 pumping sets for hiring out.

Bombay, the Punjab, Madras and the United Provinces have been giving necessary assistance to agriculturists in connection with installation of plants and repairs to machines. They are also giving necessary training in the running of their machines and assisting them in the manufacture of certain implements.

CHAPTER VIII

ANIMAL INDUSTRY*

1. General remarks

A NUMBER of events occurred during the year which may have a far-reaching effect on animal industry in India. Thes econd All-India Cattle Show was held at New Delhi in February 1939, and a society was registered for making the show a regular annual affair and for promoting the objects underlying the show. The third meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India was also held in the same month immediately after the show, and as usual this afforded a very good opportunity for workers from different parts of the country to meet, exchange ideas and experiences and discuss important problems. The Agricultural Marketing Adviser issued his report on the marketing of eggs in India, giving figures illustrating the magnitude of the industry and indicating the large potentialities it possesses. The report draws attention to the defects and tbe handicaps from which the industry suffers and shows how it could be developed. During the year preparations were also in progress and the ground-work was done for the livestock census to be held in January 1940. Through the efforts of the Imperial Council of Agricultural Research and in the light of experience gained in the application of census figures for various developmental purposes, some important modifications were introduced in the classifications. Various new classes were introduced, but at the same time care was taken to see that the new figures will be comparable with those obtained at previous censuses. An important feature of the new census is the inclusion for the first time of figures for poultry.

It has been customary in the past to issue annually a separate report on the action taken on the various recommendations of the Royal Commission on Agriculture. This publication has been discontinued but a reference to the action taken on tbe recommendations of the Royal Commission by the Central and Provincial Governments is made in this review and this arrangement will be followed hereafter.

(a) The Second All-India Cattle Show

Reference was made in the previous review to the origin of the all-India cattle show and the success which attended it in the face of heavy odds. The

* The assistance of the following officers in the preparation of this chapter is gratefully acknowledged :

Khan Sahib Ghulam Hasan, Cattle Show Officer, All-India Cattle Show Committee, New Delhi.

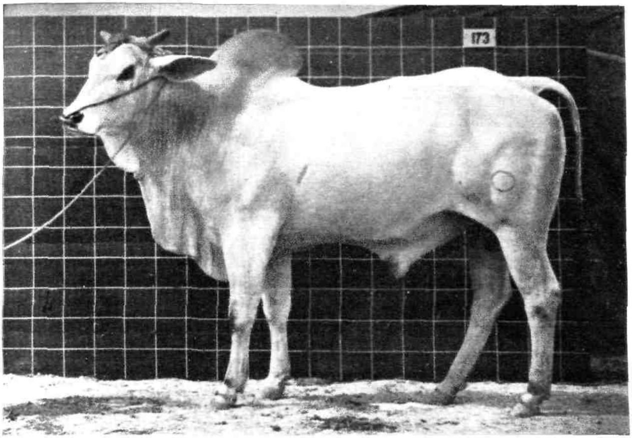
Dr W. L. Davies, Ph.D., D.Sc., F.I.C., N.D.A., Director of Dairy Research, New Delhi.

Dr H. S. Pruthi, M.Sc., Ph.D., Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi.

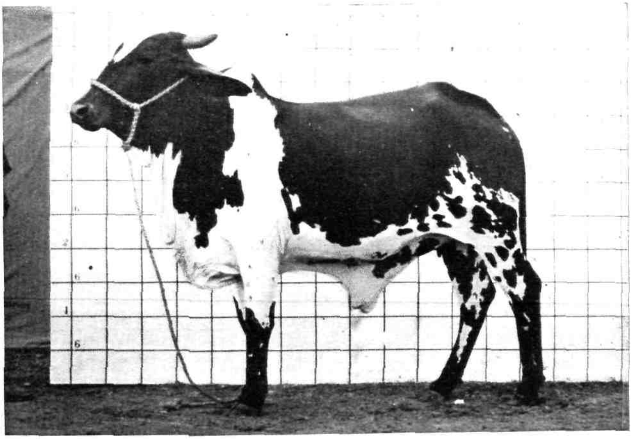
Mr C. C. Ghosh, B.A., F.R.E.S., Deputy Director of Sericulture, Bengal, Berhampur.

Diwan Bahadur Dr B. Sundar Raj, M.A., Ph.D., Madras.

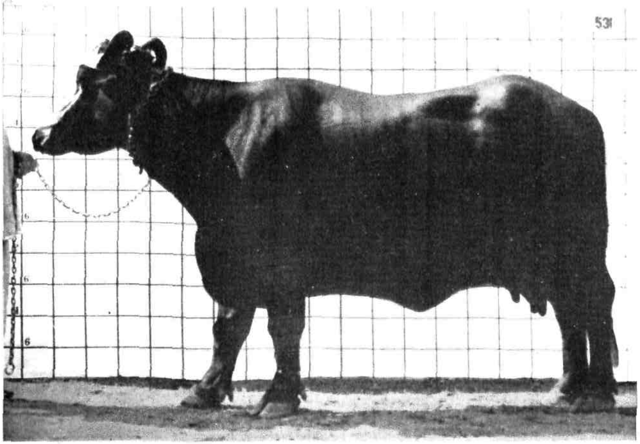
Mr A. J. Macdonald, B.Sc., officer-in-charge Poultry Research Section, Imperial Veterinary Research Institute, Izatnagar.



Hariana bull, No. 173 of 1939 show, Age 5 years
Prizes won : (i) 1st prize for the class
(ii) Best Hariana bull
Owner : Chandji of Rohtak



Deoni cow, No. 374 of 1939 show
Prizes won : (i) 1st prize for the class
(ii) Best milch cow of Southern India breeds
Owner : Hyderabad State



Murrah buffalo cow, No. 531 of 1939 show, age 6 years
Prizes won : (i) 1st prize for the class
(ii) Best Murrah buffalo cow
(iii) Best buffalo cow
(iv) Best animal in the show
Owner : Chhaju of Rohtak

show, however, demonstrated the immense utility which its sponsors had claimed for it and pointed to the necessity for making it a permanent institution. The Government of India made a generous donation of Rs. 2½ lakhs as a nucleus for the formation of a society. The formalities were attended to and the Society was registered during the year, with the Animal Husbandry Commissioner with the Government of India as the Chairman of the Executive Committee and the Deputy Secretary, Education, Health and Lands Department as the Secretary. A full-time Cattle Show Officer and staff were also appointed to conduct the work of the society.

The number of entries at the second cattle show was 637 as against 488 in the previous year and included 22 breeds of which the following were very well represented:

1. Sahiwal.
2. Hariana.
3. Hissar-Hansi.
4. Dhanni.
5. Nagori.
6. Malvi.
7. Mewati.
8. Bhagnari.
9. Murrah buffaloes.
10. Ravi buffaloes.
11. Nili buffaloes.

The Sahiwal—the most popular milch breed in India—was alone responsible for 103 entries. The number of exhibits of other breeds was also satisfactory. Out of the 27 breeds scheduled in the prospectus, five were not represented owing to certain unavoidable circumstances. The breeds which were not exhibited were the Ongole, Hallikar and Krishna Valley breeds from Madras, Mehsana buffaloes from Baroda and Nagpuri buffaloes from the Central Provinces. At the last moment some of the entries had to be cancelled due to outbreaks of foot-and-mouth disease.

All the animals exhibited were in very good show condition and the quality was also high. This affords clear evidence of the stimulus the show has given to cattle-breeding and the improvement generally of India's livestock.

It is noteworthy that among such a large gathering of animals from all over India there was no case of any contagious disease and not a single casualty. Arrangements were made for a veterinary dispensary, foot-bath and a segregation ward. When a storm broke out, shelter was provided in the Purana Qila close by.

Layout

The layout of the cattle camp, judging rings, collecting rings and the stalls, etc. was much improved. Filtered water hydrants were available at convenient centres. Cattle attendants were provided with free accommodation in *choul-daries* just behind their own animals.

Tents were pitched for the accommodation of officers who accompanied the exhibits on the raised ground very close to the cattle yard and all facilities were provided.

Concessions

Unlike shows in other countries the Society's expenses increase with the number of entries, as no entrance fee is charged at present and all animals exhibited are fed for the period of the show at the cost of the society. In addition, an adequate supply of bedding is issued free to each animal. Special concession rates for the transport of exhibits were arranged with the railway authorities and every facility was afforded to the cattle and their attendants on arrival.

Publicity

A film of the general view of the show and the cattle parade of the winners, which took place on the concluding day of the show, was prepared and exhibited on different occasions. Individual photographs of prize-winners were also taken and published in different magazines and newspapers. A number of sets of these photographs were purchased by provincial Governments and states.

Sale of cattle

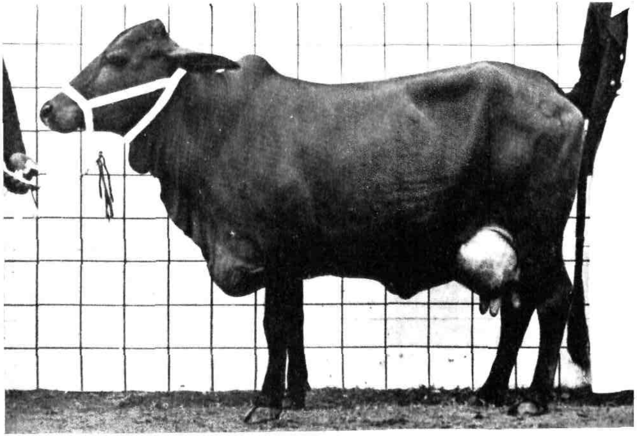
It is estimated that cattle worth Rs. 15,000 were sold during the show and in many more cases buyers obtained the names and addresses of breeders for future purchases. A Colonial Government Officer, who attended the show, purchased a considerable number of Indian cattle and buffaloes of five different breeds on behalf of his Government. It is estimated that Rs. 50,000 or more went into the pockets of cattle breeders in India.

Prizes

The prizes were given away by H. E. the Viceroy on Saturday the 18th February, and the function was attended by a large and distinguished gathering including Ruling Princes and Government and State officials. In all 40 trophies were presented, a number of which were accompanied by miniatures. Medals were given to all animals entered for the show. More than Rs. 11,000 were distributed in cash prizes, including consolation prizes of Rs. 5 each to the owners of animals which did not win any other prize.

(b) Animal Husbandry Wing Meeting

The third meeting of the Animal Husbandry Wing was held in February 1939 and was opened by the Honourable Member in-Charge of Education, Health and Lands Department. It was attended by 85 workers from all over India and as many as 19 subjects covering the entire field of animal husbandry were discussed. The subjects were first discussed in three specialist committees, viz. (1) Bacterial and virus diseases of animls, (2) Parasitic diseases, (3) Cattle-breeding and Dairying. On the diseases and pests side, topics like pleuro-pneumonia in goats, rinderpest in goats and sheep, Johne's disease, Doyle's disease, surra in horses and cattle, theileriasis of cattle and the warble-fly pest were discussed. The Cattle-breeding and Dairying Committee dealt with development of pedigree registration and milk recording, H. E. the Viceroy's cattle improvement drive, formation of breed societies, necessity for definition of breed characteristics and salvage of dry city cattle. General problems relating to control of grasslands, fodder production, necessity for establishment of cattle improvement funds, improvement of horses and cattle migrations were



Red Sindhi cow, No. 293 of 1939 show, age 7 years
Prizes won : (i) 1st prize for the class
(ii) Best milch-type cow
(iii) Best cow
Owner : Imperial Dairy Institute, Bangalore

also discussed at the meeting. The papers read at the meeting and the proceedings have been printed up and copies are available with the Manager of Publications, Civil Lines, Delhi. A list of the subjects discussed is given below with a summary of the recommendations on each subject:

1. *The etiological factors concerned in pleuro-pneumonia of goats in India*

Goat pneumonia is of very grave importance and calls for more investigation in various centres and exchange of knowledge so obtained and its correlation with hæmorrhagic septicæmia of cattle should be studied.

2. *Natural outbreaks of rinderpest in sheep and goats and their bearing on the general problem of control of this disease*

Goats and sheep are refractory to natural rinderpest infection but undoubted outbreaks occur. There is evidence that infection can descend from cattle to sheep and goats.

This subject is in the early stages of investigation which should be actively continued.

3. *The methods to be adopted for the control of Johne's disease in India*

(i) Further investigation as to the incidence of the disease in the villages is necessary.

(ii) The question of the disposal of positive reactors should form the subject of future discussions, as slaughter of such animals is impracticable.

(iii) Diagnostic tests are at present not very reliable but the Double Intradermal test may be continued and it should always be confirmed by fæcal examination.

4. *The control of Doyle's (Ranikhet) disease in India*

No recommendation.

5. *The present position regarding the control of surra in horses and cattle*

(i) The investigation of bovine surra should be included as an item of special importance in the future programme of work for the Veterinary Investigation Officers in India.

(ii) In view of the high cost of Naganol, an investigation should be undertaken to explore the possibilities of less expensive drugs in the treatment of surra, and that, if necessary, efforts should be made to secure the collaboration of one or more leading firms of chemists in this connection.

(iii) In the meantime the Bayer Company should be addressed concerning the possibility of reducing the price of Naganol so as to bring the drug within the reach of the average stock-owner in this country.

(iv) A series of intensive investigations should be undertaken to determine (*a*) the minimum effective dose of Naganol in the prophylactic treatment of equine surra; (*b*) the relative therapeutic value of N ganol alone and Naganol *cum* tartar-emetic method in the treatment of both acute and chronic cases of this condition.

(v) In those areas where surra is prevalent, surveys should be undertaken in collaboration with the Mukteswar Institute, on the likely blood-sucking arthropods with a view to ascertaining the species or the vectors involved in the

spread of the disease. In the meantime, measures should be taken, in selected surra areas, for the destruction of the egg clusters of Tabanids, which are believed to be common vectors of the disease.

6. *A review of the present position in regard to theileriasis of cattle in India*

(i) The veterinary departments of the provinces and states should be invited to collaborate with the Mukteswar Institute in an investigation into the incidence of bovine theileriasis in India by forwarding to that Institute blood and gland smears from animals that have succumbed to or recovered from blood-borne protozoan infections.

(ii) There is need for a series of controlled cross-immunity tests to determine the relationship between East Coast fever and acute forms of theileriasis in India, but these tests should be carried out in a locality where East Coast fever is definitely known to be prevalent.

(iii) In the matter of experimental work on the treatment of acute theileriasis special attention should be given to those members of the Sulphanilamide group which are of proved efficacy for certain analogous disease conditions in the human subject.

7. *The application of results so far obtained in the enquiry on the bionomics of the warble-fly for the control of this pest*

The Board is greatly impressed by the damage caused to hides by ticks in India and recommends that the Imperial Council of Agricultural Research take up the question of further research with special reference to distribution, periodicity and the stage of the tick when damage is caused.

8. *The development of pedigree registration and milk recording*

The Board considered that pedigree registration and milk recording were of great importance in the improvement of milch breeds of cattle and stressed the essential point that milk recording must be conducted with great accuracy and uniformity of method as it greatly influenced the position of pedigree registration. It was further recommended that all methods of encouraging milk recording, such as establishment of milk collecting centres, etc. should be assisted every way possible.

9. *The organisation of the supply of breeding bulls with special reference to His Excellency the Viceroy's gift bull scheme*

(i) The Board recognised the difficulties and expense attendant on rearing good dairy bulls and recommended that all agencies which could, in the opinion of the Livestock Department, be profitably employed on this work should be subsidised.

(ii) The Board was also of the opinion that all possible agencies should be employed to facilitate the production of pedigree bulls for milch and draught, and draught only.

(iii) To avoid indiscriminate location of bulls, the Animal Husbandry Wing is of the opinion that all donors under the Viceroy's gift bull scheme should be informed that the selection and location of bulls purchased from such donations should be controlled by the Livestock Department or by the Cattle Improvement Society where such exists.

FIG. 1
Portion of raw hide showing tick bites

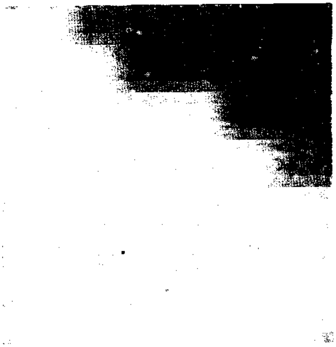


FIG. 2
Tick marks on a piece after it has been tanned

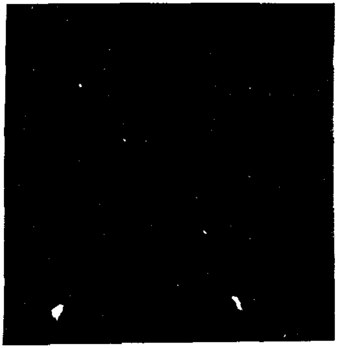


FIG. 3
Tick marks on finished leather

10(*a*). *The formation of breed societies and other lines to be adopted for the improvement of milch cattle and buffaloes*

The recommendation of the Committee that 'The committee felt that if Herd Books and registration of Indian breeds of cattle were to be made a success, it was essential that *breed societies* should be formed to work in the interests of breeders. At the same time the Committee recognised the fact that owing to the circumstances of the breeders, Government assistance and a small subsidy would be essential for some years after the breed society was formed,' was accepted.

10(*b*). *The necessity for defining the breed characteristics of certain types of cattle exhibited under breed names*

The Board has observed that a large number of grey breeds of cattle have not yet been classified by definite breed characteristics. They recommend that the Imperial Council of Agricultural Research be asked to devise means for defining the breed characteristics of these breeds. Further, the Board considered that it would be advantageous if final selections of these types could be shown at the All-India Cattle Show at the end of the enquiry.

11. *The present position in regard to the salvage of dry city cows and supply of milk to large cities*

The Committee observed with regret that no effective action had so far been taken on the previous recommendations made by the Committee which dealt with this subject in 1937 and felt that no useful purpose could be served by further reiterations and resolutions along these lines. In view of the urgency and importance of the matter, they considered that a special small committee of people, closely associated with the subject, should be appointed to investigate the question on the spot at the three Presidency towns and endeavour to elucidate a course of action which would be assented to and co-operated in by the authorities concerned.

The above report of the Committee was adopted by the Board.

12. *A review of the progress made in provinces and states in regard to the resolutions of the Cattle Conference held in May, 1937*

No recommendation.

13. *Practical methods for the improvement and control of grasslands*

The Board notes with satisfaction the varions efforts that are being made in provinces and states towards the improvement of grasslands and recommends that these should be extended and intensified and linked up with all other movements towards soil conservation and planning for better land use. Further that Local Governments be invited to consider the desirability of taking legislative powers, where necessary, for enforcing the proper utilization of grazing areas and waste lands capable of producing fodder or fuel.

14(*a*). *Methods to increase fodder production with special reference to mixed farming*

The Board emphasizes the importance of well planned experiments in mixed farming and notes with satisfaction that the Governing Body of the Research Council is prepared to give small grants to assist such experiments.

14(*b*). *Tree fodder with special reference to flooded areas*

No recommendation.

15. *The necessity for the establishment of provincial livestock associations and cattle improvement funds*

The Board desires to emphasize the value of properly organised cattle shows. It notes with satisfaction that the Central Government has provided finance for the All-India Cattle Show for a term of years and that a Show Society has been registered. District and local shows are of the greatest importance and the Board recommends that Local Governments should ensure adequate provision for the organisation and holding of such shows and for substantial prizes.

16. *The improvement of the indigenous breeds of horses*

No recommendations.

17. *The migration of cattle between provinces and states with reference to its effect on :—(a) the control of contagious diseases, (b) the breeding of pure stock*

Arrangements should be made for direct exchange of information between province and province, and provinces and states regarding outbreaks of contagious diseases of cattle.

18. *The measures which should be adopted in India in order to comply with international requirements regarding the examination and certification of animal products for export*

(i) All animals slaughtered for human consumption should be slaughtered in public slaughter-houses so far as possible and the animals subjected to *ante* and post-mortem examination by a qualified Veterinary Assistant Surgeon.

(ii) For this examination, all local bodies must employ qualified Veterinary Assistant Surgeons as Superintendents of slaughter houses.

(iii) All animals slaughtered at the slaughter-houses must be certified by the qualified Veterinary Assistant Surgeon as free from contagious diseases at the time of slaughter.

(iv) Bales of hides and skins should be marked in some way to indicate their source of origin and date of slaughter.

(v) Periodical information regarding the evidence of diseases throughout India, infected areas and the dates from which areas are declared free, should be furnished confidentially to the veterinary authorities at the ports serving those areas.

(vi) A considerable tightening up of the reporting of outbreaks of contagious diseases among livestock by local reporting officers is required.

19. *The correlation between soil deficiencies, poor cultivation, unthrifty cattle and human malnutrition*

No recommendation.

(c) All-India Egg Marketing Report*

This is the first survey ever published of a full branch of animal industry in India, and is pregnant with facts and figures relating to an occupation worth about 13 crores of rupees annually to the rural population. The general practices in the keeping of poultry and collection of eggs, the various defects in the marketing organisation, the potentialities for improvement and for adding to the slender resources of the poor villagers are all described in detail in the 300 odd pages of the report. The total value of eggs sold amounts annually to 5·25 crores of rupees, and the birds are worth about 7·5 crores. The loss

* Available from the Manager of Publications, Civil Lines, Delhi, at Re. 1-4 per copy.

due to stale eggs, breakages, etc., caused in marketing and in various other ways is estimated to be as much as 57 lakhs of rupees annually.

(d) Livestock census

Details of this Census will be referred to in the next year's report. The improved method of classification is expected to yield very important information.

(e) General health of livestock

The year under review has registered an increase in mortality from contagious diseases by about 27 thousand in British India. As will be seen from Appendix X, the mortality during the previous year was only 244,179, but it has risen to 270,968 in the current year. The following statement shows the provinces which were unhealthy for livestock during the year :—

Statement showing increase and decrease of mortality from contagious diseases in 1938-39 in comparison to figures of 1937-38

Name of province	Increase (+) or decrease (—) in mortality from the previous year (1937-38) (In thousands)	
	Total mortality from contagious diseases	Mortality from rinderpest
Madras	—7·1	+2·0
Bombay	+3·6	—3·4
Bengal	+4·3	—2·3
United Provinces	+16·3	+10·1
Punjab	—3·0	0·0
Bihar	+5·8	+4·6
Orissa	+0·8	+0·9
Central Provinces and Berar	—0·6	0·0
Assam	+11·0	+9·4
North-West Frontier Province	+0·9	+0·4
Sind	—4·4	—2·7
Baluchistan	—2·1	0·0
Ajmer-Merwara	+1·4	—0·1
Coorg	—0·1	0·0
Total for British India	+26·8	+18·9

It will be seen that the United Provinces have shown an increase of 16·3 thousand, which is more than 50 per cent of the total deaths during the previous year. Assam comes next with 11 thousand, followed by Bihar, Bengal and Bombay with 3 to 6 thousand. Among decreases, Madras heads the list with 7 thousand or 16 per cent. Other notable decreases are in the Punjab and Sind.

A word of caution seems, however, necessary in the interpretation of these figures which relate not to the total mortality, but the total *reported* mortality, so that the figures reflect not only the actual health conditions but also the efficiency of reporting. It seems justifiable to assume that with the increasing attention which animal husbandry is receiving in India, reporting is becoming more efficient and the conditions may not be so bad in some provinces as the figures show them to be.

It is interesting to examine the share of the toll levied by the different contagious diseases. The following figures show the total figures for India for the past five years.

*Mortality from contagious diseases from 1934-35 to 1938-39**

Year	Total reported mortality among bovines	Mortality from rinderpest		Mortality from hæmorrhagic septicæmia		Mortality from black quarter		Mortality from anthrax		Mortality from other contagious diseases	
		No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
1934-35	2,16,756	1,18,698	54·8	43,156	19·9	10,481	4·8	5,869	2·7	38,549	17·8
1935-36	2,28,693	1,35,251	59·1	30,750	13·4	9,498	4·2	7,118	3·1	46,076	20·1
1936-37	2,79,397	1,60,055	57·3	43,456	15·6	12,863	4·6	10,478	3·8	52,545	18·9
1937-38	2,36,177	1,15,987	49·1	53,446	22·6	19,474	8·2	10,396	4·4	36,874	15·7
1938-39	2,36,055	1,22,955	52·1	56,556	23·9	20,276	8·6	8,382	3·5	27,886	11·9

*(Since Burma has been separated from India figures relating to that country are not included in the general statistics. For purposes of comparison with previous years, however, Burma has been included in all years except 1938-39.)

It will be seen that rinderpest still claims more than half the total loss. Figures for the current year, analysed according to Provinces, are as under :

Mortality from contagious diseases among bovines 1938-39

Provinces	Total reported mortality among bovines	Mortality from rinderpest		Mortality from hæmorrhagic septicæmia.		Mortality from black quarter		Mortality from anthrax		Mortality from other contagious diseases	
		No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage	No.	Percentage
Madras . .	32,405	9,986	30·8	6,012	18·6	9,905	30·6	2,334	7·2	4,168	12·8
Bombay .	13,879	1,881	13·6	5,548	40·0	4,856	35·0	885	6·4	709	5·0
Bengal . .	22,850	14,174	62·0	3,907	17·0	234	1·0	1,107	4·8	3,428	15·2
United Provinces.	43,000	27,360	63·6	12,002	27·9	1,125	2·6	998	2·3	1,515	3·6
Punjab . .	27,753	15,311	55·1	10,938	39·4	500	1·8	0	0	1,034	3·7
Bihar . .	18,069	7,826	43·3	7,608	42·1	1,545	8·6	479	2·6	611	3·4
Orissa . .	3,592	2,440	67·9	482	13·4	9	0·3	38	1·1	623	17·3
Central Provinces and Berar.	19,327	8,057	41·7	7,193	37·1	1,917	9·9	739	3·8	1,451	7·5
Assam . .	48,247	34,120	70·7	1,507	3·1	100	0·2	1,724	3·6	10,796	22·2
North-West Frontier Province.	1,593	509	32·0	957	60·1	29	1·8	0	0	98	6·1
Sind . .	4,756	1,221	25·6	348	7·3	7	0·2	6	0·1	3,179	66·8
Baluchistan .	38	0	0	7	18·4	3	7·9	2	5·3	26	68·4
Ajmer-Merwara.	77	21	27·3	12	15·6	0	0	0	0	44	57·1
Coorg . .	439	49	11·2	70	15·9	46	10·5	70	15·9	204	46·5
Total for British India.	236,055	122,955	52·1	56,556	23·9	20,276	8·6	8,382	3·5	27,886	11·9

It will be seen that in Assam, Orissa and the United Provinces the share of rinderpest amounts to as much as 63 to 70 per cent and it is only in Coorg, Bombay, Sind, Ajmer-Merwara and Madras that the proportion is 30 per cent or lower.

Hæmorrhagic Septicæmia, which is the next in importance, claims 23·9 per cent of the total mortality, black quarter 8·6 and anthrax 3·5.

Preventive inoculations

Figures in columns 10-13 of Appendix X contain statistics of preventive inoculations undertaken in India. This is a major activity of the Veterinary Departments of Provinces in combating diseases, and it will be seen that this activity is receiving increasing attention year by year.

(f) *Gaushalas* and Society for the Prevention of Cruelty to Animals

There are two institutions in India doing a considerable amount of humanitarian work. These are the Society for the Prevention of Cruelty to Animals and the *pinjrapoles* or *gaushalas*. Their main object is to alleviate the distress of ailing animals and to prevent the slaughter of or wanton cruelty to them.

There is a very large number of these organisations scattered about the whole of India, and it is not possible to give an account of the working of all of them. From reports received from twenty S. P. C. As.; it is observed that as many as 22, 806 cases of cruelty were detected and dealt with by them during the year. Seventeen of them, for which alone figures are available, spent 1·1 lakhs of rupees. There is an Act of the Legislature called the Prevention of Cruelty to Animals Act which was amended in December 1938 and workers in the S. P. C. A. obtain conviction of offenders under this Act. They conduct a large amount of propaganda particularly at animal fairs and shows, carry out first-aid work and give free supplies of medicines in cases of cruelty. They also carry out a large amount of welfare work, including the organisation of Animal Weeks or Animal Shows, running of hospitals or dispensaries on wheels, provision of water troughs where necessary, etc. These societies work in close collaboration with the Veterinary Departments.

There are about five hundred *gaushalas* or *pinjrapoles* in India. Their common aim is to prevent the slaughter of animals, the usual motto being 'God Commandeth ! Thou Shalt Not Kill.' Many charitably disposed or religious persons and bodies contribute generally to the funds of the *pinjrapoles*, and they have large amounts of money, though the demand on their resources from the old, decrepit and infirm animals is also equally great. Sixteen societies, for which figures are available, have housed over seventeen thousand animals during the year, most of which are cattle. They have spent 5·5 lakhs of rupees or Rs. 33 per animal.

Some *gaushalas* do not confine themselves to the negative aspect of prevention of slaughter. They have a branch of their activities devoted to the constructive work of cattle improvement. Separate sections have been opened for this purpose, where selected animals are kept and bred from and dairies are run on modern scientific lines. They produce their own fodder for the cattle and the income derived from the dairies helps to supplement the maintenance charges of the whole herd.

2. Trade in animals and animal products

(a) Foreign trade

Though her livestock resources still remain largely unexploited, India possesses a larger livestock population than any other country in the world. As a matter of fact, a third of the total cattle population of the world is in India.

She, therefore, naturally occupies a prominent position in the international trade in livestock products. Detailed figures relating to India's imports and exports of livestock and livestock products are given in Appendices XIII A and XIII-B. The following is a summary of the value of imports and exports for the last five years :

Year	Value in lakhs of rupees	
	Imports	Exports
1934-35	4,98	11,88
1935-36	4,09	13,60
1936-37	4,22	16,50
1937-38	4,91	17,32
1938-39	3,75	14,11

It will be seen that the value of the trade, which was showing a steady tendency to increase, has taken a trend in the opposite direction. If the details in the appendices are examined, it will be found that the fall in imports is caused mainly by the decrease in the import of raw wool by over a crore of rupees, while the decrease in export is due to the fall in exports of hides and skins to the value of nearly 3 crores of rupees. One of the reasons for the drop is that restrictions have been placed by certain foreign countries on animals and animal products exported from India due to lack of proper certification. The other reason may be that more and better wool is produced in the country than before and more hides and skins are utilised in the home industry.

In order to try to regain the lost export trade, the Madras Government have framed rules in regard to the proper certification of animals and animal products intended for export from that port.

The value of foreign trade in individual products for the year under report is as under :

Products	Imports	Exports
	Rs.	Rs.
Live animals	30,72,030	8,22,526
Hides and Skins—		
Raw hides	3,84,394	1,02,42,615
Raw skins	12,41,728	2,78,69,546
Tanned or dressed hides	28,681	2,27,40,144
Tanned or dressed skins	11,88,899	2,48,14,564
Wool	2,27,81,901	3,84,94,559
Dairy products	54,41,966	34,09,004
Other products	33,61,024	1,26,80,794
TOTAL	3,75,00,623	14,10,73,752

(b) Inter-provincial trade

The volume of internal trade in livestock and livestock products is also very great, but it is to be regretted that there is no agency in India at present for systematically registering this. As was pointed out in the previous year's review, the information available is confined to the trade carried by rail and river. The detailed figures are given in Appendix XIII-C, a summary of which is as under:

—	1938-39	1937-38
	No.	No.
Livestock—		
Cattle	2,72,330	2,60,615
Horses	24,780	25,359
Sheep and goats	10,53,347	9,30,513
Others	3,02,621	3,52,188
TOTAL LIVESTOCK	16,53,078	15,68,675
	Maunds	Maunds
Bones	29,67,442	50,36,899
Hides raw	16,87,826	18,12,422
Skins raw	9,90,156	11,56,248
Hides and skins Tanned & leather	6,37,249	6,10,099
Ghee	7,12,513	7,62,210
Wool raw	7,68,681	5,73,911

No comment can be offered on these figures until information is available as to what proportion of the total inland trade is represented by these returns. As far as present information goes, trade by rail or river, especially of live animals, is only a small fraction of the total, which, if true, emphasizes the magnitude of the trade.

(c) Slaughter-house statistics

Reference was made in the previous year's review to the arrangements that had been made for the collection of statistics relating to slaughter in recognised slaughter houses. The position in regard to reporting has since improved slightly and the United Provinces have also furnished figures for 1938-39

Details are given in Appendix XIII D. The following are the totals, as far as available :—

Ovines	67,97,193
Bovines	12,08,690
Pigs	17,786
Others	14,822
TOTAL	80,38,491

In view of the incompleteness of the returns it is still not possible to comment on the magnitude or trend of these figures.

3. Dairying

A. Milk production and records

In order to regularize the method of recording, lactation records covering 280-320 days have been agreed to. This period has been taken since (*a*) it is generous enough for cows which are calving regularly every year and whose lactation period rarely exceeds 320 days and (*b*) it rules out inflated records of cows which remain in milk for over 365 days owing either to not being in calf or in calf with more than 365 days between successive calvings. Some high yields, however, are still reported for long lactation periods. The inclusion of the length of lactation period in a report of milk records should be obligatory.

Progress in increasing the milk yields of individuals in well-managed herds continues to be reported. The Imperial Dairy Institute report the following average breed performances : *Sindhi* (average of 636 lactations) ; purchased, 2,725 lb. (242 days) ; homebred, 3,436 lb. (276 days) ; best yield 7,116 lb. (305 days). *Gir* (54 lactations) ; purchased, 2,447 lb. (263 days) ; homebred, 2,997 lb. (299 days) ; best yield 3,480 lb. (341 days). *Murrah buffaloes* (163 lactations) ; purchased, 4,530 lb. (300 days) ; homebred, 4,577 lb. (321 days) ; best yield, 5,758 lb. (364 days).

The Sahiwal herd of the Imperial Agricultural Research Institute shows the following performances : Average daily yield, 21·2 lb. for 65 cows with an average number of 40 in milk as against 22·2 lb. (73/43) for the year 1937-38. Sixty cows completed their lactation with an average of 5,590 lb. of milk in 281 days. (The previous year's figures were 56 cows giving 5.716 lb. in 284 days).

The milk yields of members of Sahiwal herds on 3 grantee farms (Punjab) have been defined as follows : yields of 3,000-6,000 lb., 90, 70 and 70 per cent of the herds ; yields of 4,000-5,000, 50, 40 and 36 per cent of the herds.

The average yields of the Telankhery herds (Nagpur) are lower : mixed cows 2,812 lb. ; buffaloes, 2,804 lb.

At the Hebbal Farm, Mysore, 21 Hallikers averaged 1,838 lb. (range, 749-2,657 lb., lactation period not given).

The half-bred herd of the Upper Shillong Farm, Assam, gave an average yield of 7,020 lb. (328 days), the best yield being 10,086 lb. (373 days). The progress during the 10 years the herd has been in existence is evident from the increase in average annual yield from 2,500 to 7,742 lb.

Data from the milk yields of selected animals on the Hissar Farm confirm previous statistical work on lactation yields, viz. :—that the best yields are given in the second to the fourth lactation.

Reports from the three circles of Military Dairy Farms continue to provide data on the effect of foreign blood (Friesian) on the milk yields of indigenous cows. The grade of the cow can be described by the amount of foreign blood in her, e.g. 7/8ths, 3/4ths, 1/2 (cross-bred), etc. The pure Western breed in the Northern Circle, imported or farm-bred, gave the highest yield, namely 8,545 lb. (13 animals, 269 days) ; all animals with a yield over 6,000 lb. possessed 50 per cent or over of foreign blood. This indicates clearly the effect and the importance of foreign blood in increasing milk production on these farms.

Data for individual animals showed that grades from cross-bred to pure Friesian were the best yielders, e.g. from 10,050 to 15,800 lb.

Some of the Sahiwals in this Circle, especially those at Ferozepore, have good records, one yielding 10,061 lb. in 316 days. The average yield of 27 animals (295 days), however, was 5,690 lb., and 12 at other farms 4,695 lb. (305 days).

The above figures apply to adult animals. The same trend of results was obtained for first calf heifers, those of grades above cross-bred giving over 5,000 lb. in lactations averaging 300 days.

The Northern Circle now rears a large number of milch buffaloes taking advantage of the surplus separated milk. The number of milch buffaloes reported on for the year was 1308, giving an average milk yield of 3,389 lb. over an average lactation period of 271 days.

The Southern Circle reports an average yield of 3,079 lb. for indigenous, 9,641 lb. for Indian Friesian, and above 6,000 lb. for all grades except those with 1/4th European blood. In the Frontier Circle, the same results as in the Northern Circle Farms were obtained ; animals with 50 per cent and over of foreign blood gave over 5,000 lb. (Group A) ; all other crosses gave over 4,000 lb. (Group B) ; the indigenous animals gave less than 4,000 lb. (Group C). The average for the Sahiwal breed was 3,107 (12 cows, 222 days).

The records for the buffaloes were : Southern Circle, 1,622 animals, averaging 8·9 lb. per day ; Frontier Circle, 1,067 animals, 3,365 lb. per period of 216 days (daily yield, 8·3 lb.).

B. Milk handling and technology

There is apparently small opportunity in India for extended work on milk handling and treatment and on the preparation of indigenous and western milk products. Nevertheless some work has been done which shows distinctly the spirit of progress and this will be briefly described below.

(i) *Hygienic production of milk*

It is realised that progress in hygienic methods of production and the implanting of the idea of hygiene into milkers and milk ' andlers in India will be a slow process, which can only be achieved by patient teaching and demonstration. These principles are continuously being taught in various courses at dairy institutes and agricultural and veterinary colleges and demonstrated at agricultural and cattle shows. High atmospheric temperatures and other conditions peculiar to India demand special studies of clean milk production.

The principles of clean milk production are observed extensively on military dairy farms and on college, institute and many private dairy farms. The Imperial Dairy Institute reports that control tests for hygienic quality by plate count, presumptive *B. coli* and methylene blue tests have been carried out and as a result of the application of the findings of these tests towards the tightening up of cowshed and dairy practice, longer keeping milk and better quality cheese have been produced. Tests on utensils and bottles have defined the perfection of cleaning operations and the efficiency of detergents and sterilising operations.

(ii) *Fermented milk products*

Dahi and *lassi* are indigenous products prepared by the lactic fermentation of milk. Work has been done at the Imperial Dairy Institute on the chemistry and bacteriology of *dahi*. The growth of *dahi* organisms with successive propagations arrives at such a distribution of bacteria which can be successfully reproduced commercially. These fixed but mixed cultures form the starters used in cheese and buttermaking. Many centres in India act as distributors of these cultures to private dairy concerns.

(iii) *Milk composition*

A great deal of information on the composition of cow and buffalo milk, both from individuals and that bulked from herds, is being collected by dairy institutes, colleges, public analysts of towns and provinces and by private dairies. Individual animals show great variation in the composition of their milk but bulk milk is much less variable. Fat content of milk has not yet been adopted for defining the performance of dairy animals. Both the total solids and fat contents of the milk of Indian indigenous cows are higher than those of Western breeds. Those of buffalo milk are higher than those of Indian cows' milk. The calorific value of buffalo milk is almost twice that of Western cows' milk. There is a gradual increase in the fat content of the milk of farm-bred animals (Sindhi) from the first lactation onwards. A special study on the detailed composition of Indian milk is being made at the Allahabad Agricultural Institute.

(iv) *Milk products*

The connection between the acidity of milk and cream on the flavour and aroma of *dahi*, *lassi*, butter and ghee has been well established. The preparation of starters which can be successfully propagated under non-laboratory conditions and their distribution, constitutes a valuable service rendered by many institutions.

Butterfat

The Imperial Dairy Institute, in cooperation with the Indian Institute of Science, Bangalore, has investigated the effect of feeding various oilcakes, and of rations free from vegetable oil, on the composition of butterfat and the properties of the resulting butter and ghee. There is a tendency for the constants of the butterfat to be influenced by those of the fat fed, as if natural butterfat was mixed with a small percentage of the foreign fat, and textures of butter and

ghee also undergo a marked change. The maximum carotene and vitamin A enter butterfat when cows are on green pastures and on mostly a carbohydrate ration. Different breeds of animals and even individuals of the same breed vary in their ability to transfer carotene from the food into their milk.

Butter

The control of the moisture content of butter manufactured under Indian conditions is a serious problem, as the conditioning and the temperature of cream may be such as to prevent the efficient pressing out of excess water in working the butter. The resulting product may thus contain above 16 per cent moisture which is the maximum allowed in all other countries in the world. Proper conditioning of cream and churning at low temperatures overcomes this difficulty.

Ghee

The amount of work done during the year on the manufacture, quality, composition and analysis of ghee has been considerable. This is demanded by the enormous trade in the product; analysis has been given more prominence due to the control of graded ghee and the ever-present evil of adulteration with cheaper fats.

Work has been done at the Imperial Dairy Institute, Bangalore, on the method of making *desi* butter, from which much commercial ghee is made. Linked up with this is one of the main points to consider in ghee making—that of obtaining the maximum yield. The best yield of *desi* butter is obtained when conditions are such as to give a solid butter. Fat lost in the *lassi* is, however, not lost for nutritional purposes.

Good results have been obtained by making ghee direct from cream of 50 per cent fat content. The yields however can be improved upon. Various methods of preparation of ghee have no effects on the constants of the ghee butterfat.

The higher value of ghee nutritionally when compared with other fats rests largely on its content of fat-soluble vitamins. The preservation of these vitamins under conditions of treatment during manufacture and during storage, has been investigated. Ghee contains protective factors which act as preservatives for a reasonable length of time of storage (3-5 months). It is high acidity or conditions which are conducive to a rapid increase in acidity during storage which are mainly responsible for lowering the vitamin A content of ghee.

The analytical chemistry of ghee has been concentrated on (*a*) determining natural variation in ghee composition and (*b*) methods of detecting adulteration of ghee with cheaper foreign fats. No original methods of fat analysis have been brought out. When various fats are exposed to ultra-violet light fluorescences of various colours are given. These colours are due to substances such as sterols, vitamins, etc. present only in traces in fats. The possibility of using fluorescence methods for detecting gross adulteration of ghee has been suggested. No attempt has been made to make the methods detect additions of 5-10 per cent of foreign fat by the physical definition, such as by spectrum analysis of the fluorescence. An accumulation of data arising in the routine analysis of commercial ghee adds greatly to the knowledge of what is the average composition of Indian ghee.

The Agricultural Produce (Grading and Marking) Act 1937 has considerably helped the development of the ghee industry. This Act was applied to ghee, and during the year as much as 48,860 maunds of graded ghee valued at Rs. 24 lakhs were put on the market under the AGMARK seal. The grading was done by duly authorised merchants who had laboratories and equipments for testing. The graded ghee fetched better prices, which in turn encouraged the producers to produce a pure product.

Other products

The effect of the composition of milk on the texture and quality of *khoa* prepared from it has been studied.

The use of a vegetable rennet prepared from *Withania coagulans* as a substitute for animal rennet in junket and cheese making shows it to be fairly good substitute. The method of extraction and the extract itself require standardization.

Dairy plant and engineering

The Imperial Dairy Institute has investigated the applicability of various pieces of dairy plant for Indian conditions and has tested new dairy appliances used in dairy husbandry and milk production. Ghee boilers of small and large types have been successfully designed and special boilers for making ghee direct from cream have been made. The large boilers can also be used as ghee heaters.

Attempts have been made to make small butter churns from indigenous hard woods, but with no success in the case of Mysore teak. Nandi timber is being tried.

Constructive and testing work on pieces of plant such as milk coolers, ghee boilers, casein driers and spray drying plant have been done in various Indian institutions.

C. Milk collection and marketing

Milk supply unions

Voluminous data on the volume, prices and methods of marketing of milk have been collected, and the report of the Agricultural Marketing Adviser on Marketing of Milk is eagerly awaited.

The cost of production and sales rates (in brackets) of some dairy products sold at the Imperial Dairy Institute, Wellington were as follows : milk per lb. annas 2-11 (2/0) ; cream per lb. Rs. 1-14-10 (Re. 1-0-0) ; butter per lb. Re. 0-14-2 (Re. 1-0-0). The sales rates per lb. of the produce from the Northern, Southern and Frontier Circles of Military Dairy Farms for milk, butter and cream respectively were : milk, annas 1-7, 1-9 and 1-5 ; butter, annas 15-8, 15-8 and 15-2 ; cream, annas 15-10, 15-10 and 15-12.

Cooperative milk supply unions

These societies aim the equitable exploitation of milk and its products and provide the most successful means of supplying village milk in sufficient bulk for urban consumption. The unions concerned have to bear the expense of

collection of the cultivators' fragmentary production in each village, the receiving and treatment of milk at convenient collecting centres, transport to populated centres and the treatment and retail of the milk at the consuming centres. The milk has to be retailed at a price competitive with that charged by *goalas* for milk of uncontrolled compositional and hygienic quality.

It is to be regretted that four societies in Assam (Sylhet group) have had to go into liquidation owing to a poor financial position. The societies still working number 16 and these show a working profit. In Baroda 6 out of 11 milch cattle societies have had to go into liquidation, but 4 out of the other 5 are solvent. Bombay, Travancore and Madras report satisfactory progress for various societies. Great importance is attached to the supply of pure milk through cooperative agency for urban areas. These societies will evolve into satisfactory dairies and lead to improvement in the breeds of milch cattle. The Lucknow Cooperative Milk Union has shown satisfactory progress.

4. Poultry

The major activities in regard to poultry in most provinces and states have been devoted to 'grading-up' the village stocks through the distribution of pure-bred stock and hatching eggs. Unfortunately the full value of 'grading-up' cannot at present be estimated as no information has yet been collected in regard to relative values of various breeds or crosses under village conditions. The work of stock improvement, as in former years, has been very seriously hampered by outbreaks of disease both at the distribution centres and in the villages. Lack of knowledge in regard to housing, feeding and management are important contributory factors to the very heavy losses incurred during rearing. The work of stock improvement could also be considerably facilitated by the extension of better marketing facilities as in many areas the producer reaps no benefit from the production of a larger sized egg.

The Poultry Research Section, Imperial Veterinery Research Institute, Izatnagar

The Poultry Research Section at Izatnagar was opened by His Excellency Lord Linlithgow, the Viceroy and Governor General of India, on the 11th of March 1939. The new station will carry out fundamental research on all branches of production and marketing and act as a central information bureau for all parts of India. The laboratory building provides facilities for disease research, marketing, including the processing and storage of eggs and poultry, and for nutritional and physiological investigations on growth and production. The importance of disease control has been recognized by the Imperial Council of Agricultural Research by sending an officer for two years' training in England in November 1938. Schemes are also being elaborated by the Council for the provision of provincial Poultry Disease Investigation Offices to cooperate in this problem. The poultry farm at Izatnagar which will eventually contain at least 1,000 adult laying stock has been established and work is proceeding to test out the suitability of various breeds and crosses for Indian conditions. The results obtained on the farm will at a later date be tested out under village conditions. Growth experiments with various breeds of chickens have demonstrated the unsuitability of cereals as the sole source of

nutrition. The addition of separated milk or vegetable proteins and salt to cereal diets reduced mortality to a low level and greatly accelerated the rate of growth.

At Gurdaspur, PUNJAB, work has continued on the improvement of two egg-laying strains of indigenous fowls. Both the selected breeds have considerably higher production than unselected village fowls but the work is continuing in order to fix colour in both the breeds. The activities of the poultry farm were considerably extended under a scheme financed by the Imperial Council of Agricultural Research for the improvement of indigenous poultry for table purposes. Accommodation has been provided for six breeding pens each containing 12 females and one male, together with rearing and fattening facilities. Three pens of Asils, one pen of Chittagongs and two pens of station bred stock were tested out for egg production, hatchability, rearability and rate of growth.

In BOMBAY, 270 pure-bred cockerels were distributed free of charge in various districts in order to improve the village fowls. In addition to sales to private individuals, 354 birds and 637 settings of hatching eggs were sold to cultivators at concession rates. The smooth working of the above schemes was, however, considerably impaired by outbreaks of highly infectious diseases such as Ranikhet disease, Fowl Cholera and Tick Fever. The scheme of research financed by the Imperial Council of Agricultural Research was continued at Kirkee and two sub-stations. The following average annual egg productions were obtained :—

Chittagongs 83, Naked Necks 100, Naked Necks × White Leghorns 120, Khaki Camphell ducks 96 and Indian Runner ducks 46. The average egg size for the various breeds were 1·43 oz., 1·15 oz., 1·62 oz., 2·06 oz. and 2·16 oz., respectively. The substitution of rice bran for wheat bran in the ration of growing ducks proved very unsatisfactory both in regard to rate of growth and general health.

In BENGAL, the wide demand for pure stock could not be fully met from the Government Poultry Farm and stock cockerels and hatching eggs were imported from the United Provinces. In order to meet the ever growing demand, the Government has sanctioned the establishment of five poultry breeding centres. Seven new poultry demonstration centres were started and each was supplied with 20 good male birds and 20 dozen hatching eggs from improved breeds. During the year 440 breeding males and 440 dozen hatching eggs were distributed to cultivators. The work of stock distribution which has extended to 1,406 villages has been aided by private donors and several Unions and District Boards. Stock improvement, however, as in former years has been considerably retarded by outbreaks of diseases. A review of the breeding experiments carried out at Dacca farm 1933-39 show that the 1st generation—Rhode Island Reds × Chittagong gave as good egg production as the Rhode Island Reds but that each successive later generation of the crosses gave lower egg production. The egg production of the 6th generation of the Rhode Island Red × Chittagong was no higher than that of the pure Chittagong.

At the Livestock Research Station, Hosur, MADRAS, the average annual egg production for all trapnested stock was 146·7 against 166·9 for the previous years. The average annual egg productions for the different breeds were :— White Leghorns 177, Rhode Island Reds 137, Light Sussex 126, Black Minorcas

122 and Chittagongs 101. Hatching eggs and breeding stock of pure breeds were sold from the Central farm and other distribution centres.

In ASSAM, at the Government farms at Upper Shillong, Khanapara and Jorhat, stocks of Rhode Island Reds, White Leghorns and Black Minorcas were maintained for stock distribution to the village breeding areas. Khaki Campbell ducks at various centres gave low egg production and hatchability and high mortality during rearing. Two local breeds, the Nugeswari and Sylhetimete, both gave much more staisfactory results than Khaki Campbells under village conditions.

In the CENTRAL PROVINCES, 80 breeding cockerels were distributed free of charge to agriculturists in vorious districts.

At the Government poultry farm at Himayatsagar, HYDERABAD, various pure breeds are being maintained in order to test out the most suitable breeds for local conditions. Adult birds and hatching eggs were sold for stock improvement.

In BARODA, various pure breeds were maintained at various Government farms and stocks from these were distributed to auxiliary private farms which were established in order to grade up the village fowls by the distribution of pure breeds to replace birds of unknown origin.

5. Minor industries

(a) Apiculture

Interest in bee-keeping increased enormously during the year under review both among students and the general public. The Imperial Entomologist received over two hundred enquiries from different parts of India on various aspects of apiculture, such as methods of starting work, appliances, importation of foreign bees, diseases, composition and food value of honey, economic possibilities of the rock-bee (*Apis dorsata*), etc. The increased demand for artificial comb-foundation was also met as far as possible.

The Governments of the Punjab, Bombay, Mysore, Madras and Assam maintained apicultural stations for training, demonstration and research. In the United Provinces, a Government apiary was newly started at Jeolikote. The Government Entomologist, Central Provinces started a bee-keeping centre in Nagpur, with the co-operation of the Nagpur District Village Uplift Committee.

In addition to the usual activities of research on bee-pasturage, breeding, etc., investigations were made in the Punjab on the size of worker cells made in nature by different varieties of *Apis indica* with a view to finding out suitable cell sizes in comb-foundations for different varieties of bees. The researches at Coimbatore mainly dealt with flight-range of bees, bee-enemies, re-queening, granulation of honey, etc. Over 2,000 hives were working in the Madras Province during the year under review. 'Honey weeks' and exhibitions, organised by the Madras Agricultural Department were extremely popular.

In Mysore, in addition to the usual advice, free help was given to numerous persons in starting new hives and in extracting honey. Attempts were also made at Bangalore and Travancore to establish colonies of Carniolan and Italian bees imported from Australia, but it appears that colonies have not been established so far.

Bee-keeping was started at the Fruit Experiment Station, Kirkee, Poona in the Bombay Province. A preliminary survey of the Province was made for finding suitable localities and varieties of bees. Colonies of *Apis indica* were brought from the Gandhi Ashram, Trichengodu in South India and established in Poona. Domestication of wild varieties of bee (*Apis indica*), artificial feeding, bee-pasturage and training and demonstration were part of the activities of the centre. Some attempts were also made to induce the rock-bee, *Apis dorsata*, to hive in specially constructed frames but in no case was a colony established. Similar attempts at domesticating the small bee, *Apis florea*, resulted in the successful establishment of only one colony, but only 4 oz. of honey were obtained after six months. A colony of another bee, *Melipona* sp. is progressing well.

The All-India Bee-keepers' Association has started an *Indian Bee Journal.* The first All-India Bee-keepers' Conference was held at Delhi in December, 1939, under the auspices of this association, and in connection with this an exhibition and demonstration of comb-foundation manufacture were arranged in the laboratory of the Imperial Entomologist, New Delhi.

(*b*) Sericulture

The sericultural industry continued to suffer from depression and a further fall in prices of both cocoons and raw silk was experienced during the year. The protective duties adopted with effect from 1st May, 1934 were not able to check the imports of raw silk, silk yarn, artificial silk yarn and piece goods (silk, artificial silk and mixed). The year 1937-38 showed an unprecedented rise in price in practically all items, except silk yarn and artificial silk piece goods, but the year 1938-39 showed a fall in all items. In the year under report Japan's share of raw silk decreased considerably, but this decrease was made up by China. The second Tariff Board on the sericultural industry was appointed during the year and carried out an investigation and survey of the conditions since protection was imposed. All the sericultural provinces and states prepared and submitted reports and replies to a questionnaire issued in connection with this enquiry. A brief report of work in all the sericultural areas is given below except Kashmir and Jammu from which no report was received. Sericulture has recently been started in Bihar and Central Provinces but no report has yet been received from them.

MYSORE silkworm seed production and supply constituted the major item of work of the Mysore Department. Here multivoltine races of worms are reared. Two kinds of eggs were produced and used, viz. pure Mysore and first generation cross-bred between pure Mysore and foreign races of worms.

The total output of pure Mysore, pure foreign and cross-bred layings from Government grainages was 4,968,888 layings out of which 27,949 were used in sericultural farms and 4,626,296 were supplied to nearly 13,000 sericulturists. The cost of production was 12 as. per 100 layings as against 11 as. 5 pies last year. With the addition of five new ones, the number of working aided grainages was 30 which prepared 5,533,712 layings (676,807 Mysore and 4,856,905 cross-bred) and supplied 5,406,030 layings to 7,579 sericulturists in 1,624 villages. The cost of producing 100 layings was 14 as. 8 pies as against 14 as. 2·7 pies last year. The aided grainages incurred an expenditure of Rs. 50,727

towards which they earned and were paid by Government bonus amounting to Rs. 26,989 as against Rs. 19,635 in the previous year at the rate of Rs. 5 per 1,000 layings supplied to and successfully reared by sericulturists.

The total seed supply arranged for by the Department to sericulturists was about 101 lakh layings with 87¼ lakh cross-bred as against 93 lakh with 70½ lakh cross-bred in the previous year. Three cooperative societies produced 17,769 layings. Six other societies worked as aided grainages.

Mulberry acreage was 27,187 as against 26,175 and 25,132 in the preceding two years.

Sericultural loans to the extent of Rs. 350 only were given. Recoveries during the year amounted to Rs. 6,801 and Rs. 5,508 was written off out of outstanding arrears.

New experiments on cost and methods of mulberry cultivation, on rearing of various races of worms and grainage work were undertaken and those already in hand on manures, grafts, improvements of races of worms etc. were contiuued. Research on refrigeration of multivoltine seed cocoons and Indo-Japanese cross-bred layings was completed. It has been found that under Mysore conditions cocoons of the 6th day of mounting can be refrigerated for three days and those of 9th and 10th day of mounting for six days. Cross-bred layings 48 hours old can be refrigerated for 20 days as in the case of the Mysore race. Two new items of research, one on the combined refrigeration of seed cocoons and layings obtained from them and the other on hibernation of univoltine and bi-voltine eggs, were started.

Sericultnral training in different sericultural farms was completed by 17 students and there were 25 new admissions during the year. Five students from Bihar, Assam and the Punjab were among those under training. Six science graduate were selected by a committee and awarded stipends for receiving training at Channapatna.

Sericultural education was arranged for in four Government Middle Schools in which 284 pupils took sericulture as an optional subject and out of 60 of the final year class 54 passed in the subject.

The cocoon markets at Channapatna and Closepet worked satisfactorily and helped 485 rearers to sell 92,750 lb. cocoons to 49 reelers. Steps were being taken to remove the third market at Mugur elsewhere.

Reeling in filature is now in private hands. The Government filature at Mysore was transferred in 1938 to the Mysore Silk Filatures Ltd. aud the company arranged for training of reelers with 40 basins at its filature at T. Narsipur and hoped to have 184 basins working by November, 1939. The company arranged for getting cocoons raised from eggs produced under its own supervision.

The Department worked out an improved type of *charka* for domestic reeling and took measures to introduce it among *charka* reelers.

BENGAL. The climatic conditions were unfavourable practically throughout the year and the most important rearing district, *viz.* Malda, suffered from drought followed by heavy rains and floods of unprecedented severity which destroyed houses and mulberry.

Silkworms reared in Bengal are the indigenous multivoltine races, Nistari and Chhotopolu, the former predominating. The two newly introduced multi-voltine hybrid races, Nistid and Nismo are spreading. The seed used in Bengal

was in the form of seed cocoons which were produced and supplied to rearers by two agencies, viz. seven Government nurseries and 528 selected seed cocoon rearers. The nurseries maintained stocks and raised seed cocoons from cellular seed and supplied them to general rearers as well as to selected seed cocoon rearers. Cellular seed was produced for the seed rearers from seed cocoons meant for them in ten seed examination centres or grainages. Cocoons raised from this cellular seed were sold to general rearers. The nurseries raised 10,838 *kahan* (*kahan*=1,280) seed cocoons equivalent to about 4,877,100 layings of eggs and the seed rearers raised 55,293 *kahan* seed cocoons equivalent to about 24,881,950 layings of eggs.

Twelve silkworm rearers' sons were trained in two sericultural schools maintained in the two principal sericultural farms at Piasbari and Berhampore.

Sericultural education of an elementary nature was imparted to 279 boys and 58 girls in 8 primary schools to which monthly grants were made varying from Rs. 5 to 7.

Monetary help was rendered to six successful students of sericultural schools at Rs. 250 each and to 125 seed cocoon rearers to the extent of Rs. 5,200 for building rearing houses or improving them. Disinfectants were supplied free to seed cocoon rearers.

The district propaganda staff carried out demonstrations in the improved methods of rearing, improved rearing houses with provision of ventilators and protection against the parasitic fly and carried out disinfection of houses and appliances especially when diseases occurred.

Agricultural loans amounting to Rs. 7,016 were given to 1,129 rearers and Rs. 1,912 was realised out of past loans.

Research was being carried on for improvement of worms and cocoons, for improvement of mulberry and for control of diseases of worms and mulberry. A new hybrid race Itan was in course of fixation. A high bush form of grafted mulberry was raised and a means of controlling tukra disease of mulberry was worked out.

For the improvement of raw silk, the Peddie Reeling Institute at Malda was fully equipped and brought into working order, six reeling demonstration parties worked in the districts and the Raw Silk Conditioning House at Howrah was fully equipped. The Reeling Institute trained six students in the improved methods of reeling, and carried out experiments with reeling machines and methods. The Conditioning House carried out tests mainly to study defects and means of removing them in cooperation with the Reeling Institute.

MADRAS. The worms reared here are the Mysore multivoltine. Production and supply of disease-free seed in Kollegal was carried out with the help of eight aided grainages and a peripatetic rearing party consisting of one rearer, fourteen moth examiners and a reeling demonstrator distributed in 15 important rearing villages. The eight grainages distributed 825,636 and the party tested 2,755,949 layings as against 526,856 and 3,043,395 layings respectively in the previous year.

Adverse climatic conditions characterised by low rainfall and low prices of cocoon and raw silk affected the industry indicated by the fall of mulberry acreage to 5,735 from 7,060.

The department experimented unsuccessfully with rearing of 890 ounces of univoltine layings received from France and Kashmir. Some white cocoons,

however, were obtained for cross-breeding work about which some trials were carried out which seemed to be hopeful.

Research was carried out on infection by pebrine through routine sericultural operations and the effect of ventilation on pebrinised worms.

Four sericultural farms were maintained at Coonoor, Palmaner, Hosur and Thadaguni, where work on mulberry and worms was carried on. The rearings carried out gave materials for selection of worms and cross-breeding and also for gut preparation.

Experiments on silkworm guts were continued. Univoltine worms yielded gut 12 to 16 inches and cross-bred worms 7 to 13 inches long. Sample consignments were supplied to the Medical Store Depot.

ASSAM. Silkworms reared in Assam comprise mulberry fed ones locally called *pat*, *eri* fed on castor leaf and *muga* fed outdoors on *sum* (*Machilus odoratissima*), *sualu* (*Tetranthera monopetala*), *chapa* (*Michelia oblonga*) and mezankuri (*Litsea citrata*).

The climatic conditions in Lower Assam were unfavourable especially for *muga* worms.

The sericultural development scheme financed by the Government of India maintained on a temporary basis twenty sericultural seed examiners and demonstrators and two supervisors who, along with the six permanent demonstrators maintained by the Department, worked in 26 circles for elimination of diseases among *muga*, *eri* and mulberry silkworms, for rendering technical help to rearers and reelers in villages and for arranging for rearing *muga* seed cocoons in the southern part of Kamrup district for supply to Upper Assam. This staff looked after 156 model rearing houses in which 135,937 disease-free layings were produced, and they also distributed 142,032 disease-free layings from Government nurseries, carried out plantation of 23,545 mulberry cuttings, sold 255 *charkas* and 10 *muga* reels, surveyed 400 villages and got 2,895 *sum*, *sualu* and *keseru* seedlings planted in Assam Valley.

The department maintained two sericultural stations, one at Titabar and the other at Shillong. The former grew food plants for and carried out rearing of all the three kinds of worms. In both the stations different races of *pat* were under rearing, viz. French and Japanese univoltine and bi-voltine, local Assamese race and hybrids between the foreign and indigenous races.

PUNJAB. The Punjab showed all round progress. Eggs totalling 456 ounces were produced during the year as against 146 ounces last year. Twenty selected rearers were helped to set up model rearing houses and rear seed cocoons under supervision which were expected to yield about 1,000 ounces of eggs for the next crop. Locally produced eggs cost Rs. 1-5 and were sold at Rs. 1-8 per ounce. Imported eggs cost Rs. 2-6 and were sold at Rs. 2 per ounce. Only about 1·4 per cent of the locally produced eggs failed to hatch as against about 6·4 per cent of the imported eggs.

Eggs totalling 1,493 ounces were distributed to 838 rearers in 312 villages as against 997 ounces to 598 rearers last year.

One year old mulberry seedlings of approved varieties numbering 56,429 were distributed free of cost and freight to zamindars as against 46,400 last year, but this met only about 50 per cent of the demand. A new mulberry plantation was started at Palampur.

Owing to introduction of reeling as a cottage industry, the Government Demonstration Filature and Silk Throwing Factory, Amritsar did not get sufficient supply of cocoons. Therefore a scheme was adopted of subsidising 150 rearers to the extent of Rs. 10 worth of eggs, leaves and appliances to each on condition that they would sell their cocoons to the factory at the current market rates.

A small experiment of rearing 50 layings of *eri* eggs and of spinning the resultant cocoons with a machine introduced from Assam was carried out successfully.

The sericultural training class started last year was continued and admitted 13 out of 85 applicants.

(c) Pisciculture

A comprehensive review of pisciculture in India has not so far been published. It is therefore proposed to give a short history in this volume and to deal with further developments in subsequent volumes of *Agriculture and Animal Husbandry in India.*

For a history of the literature on Indian fishes, reference may be made to Dr Hora's article in *Jour. Royal Asiatic Society*, Science I, for 1935, B. L. Chauduri's Presidential address to the Zoological Section of the Indian Science Congress, 1917 and to 'The Progress of Science in India during the past twenty-five years' issued at the Jubilee Session of the Indian Science Congress in 1938.

Scientific studies of the fish fauna of India have been made more or less continuously from the time of Bloch (1785). The accounts of work and reports on fisheries, as such, however, have not so far been brought together. Interest naturally first centred on the ancient and historic pearl and chank fisheries of South India, and the first fisheries officers appointed in India were those concerned with the supervision and administration of the pearl and chank fisheries in the Gulf of Manaar. The available records of pearl fisheries on the Indian coast date back to 1663 from the time of the Dutch in South India. Regular inspections of the pearl banks have been held since 1863, of which reports exist.

The development of great irrigation projects in India under Sir Arthur Cotton was directly responsible for evoking interest in inland fisheries. In 1867 Sir Arthur Cotton himself called attention to the adverse effects on fisheries of the weirs and dams already constructed in seven principal rivers of the East Coast. The Madras Government were thereupon instructed by Her Majesty's Secretary of State to institute enquiries. To this we owe the appointment of Day as the Inspector-General of Fisheries in India in the early seventies of the last century. His contributions to our knowledge of the fish fauna of India are too well known to need attention here.

In 1873 two comprehensive reports on the fresh water and sea fisheries of India were published by him. They are still the only reports on fisheries for the whole of India. Unfortunately with his retirement the post was allowed to lapse and since then, in the absence of any central fisheries organisation, work has been intermittent and piecemeal, and confined to a few individual provinces.

Subsequent to Dr Day's researches, the investigations from 1881 to 1926 of the R. I. M. S. *Investigator* provided an opportunity for marine fishery research for India as a whole, as she carried a Surgeon-Naturalist, but this has now ceased as the post has not been filled since 1926. The Indian Museum until 1916 and the Zoological Survey subsequently are the only all-India institutions left for any biological research on fish, but their scope is bound to be limited as they are primarily concerned with faunistic and taxonomic work. During the years which have intervened since the time of Dr Day, attempts have been made both within and without India to arouse interest in the fisheries of the country as a whole. The largest rivers are not confined to any one province, and conditions in lakes, tanks and ponds as well as the characters of the fish concerned do not radically change from province to province. Sea fisheries are even more homogeneous and the problem of exploitation and trade are those of India as a whole. In 1920 a Committee was appointed by the British Association for the Advancement of Science to consider the question of marine biological and fishery research in India and they came to the conclusion that a Marine Biological Station for India was essential. Proposals for its establishment, however, did not materialise. The Royal Commission on Agriculture in their Report (1928) recommended that all measures practicable should be taken to add fish to the diet of the cultivator. They deprecated the tendency in the provinces to look upon fishery departments as sources of revenue and recommended the strengthening of fisheries staffs in the provinces. In 1932 a resolution intended to start research in pisciculture brought before the Legislative Assembly (Central) by Mr R. V. Jadhav was disallowed, fisheries being a transferred subject. In 1938 the Jubilee Session of the Indian Science Congress held in Calcutta in conjunction with the British Association passed a resolution urging upon the Government of India the necessity and importance of constituting an All-India Department of Fisheries for the development of the fishery resources of India on scientific lines. The reply of the Government of India, however, was that, while they sympathised with the proposals, since fisheries was a transferred subject, any move for a central institution would have to come from the Provincial Governments.

The Imperial Council of Agricultural Research, which was formed in 1930 as a result of the recommendations of the Royal Commission on Agriculture, naturally gave priority to agricultural and veterinary schemes, and it was not until later that the claims of fisheries began to be recognised. The fisheries schemes so far approved by the Council are—

(1) *Madras.*—Research on rural pisciculture and establishment of a freshwater biological station.

(2) *Bengal.*—Investigation of life-history, bionomics and development of freshwater fishes in Bengal.

(3) *Orissa.*—Biological investigation of the Chilka lake fishery.

Since the close of the year the *ad hoc* Committee on Fisheries, which used to be called at irregular intervals, has been given a permanent basis amongst the commodity Committees of the Council.

Below is given a brief account of fisheries work attempted in the various provinces and states so far as can be ascertained from reports, scientific journals, and newspaper articles.

I. Historical survey

MADRAS. The Madras Department of Fisheries was founded in 1907 after enquiries made by Sir F. A. Nicholson in India, Japan, Europe and America. The staff consisted of a Director, who was in charge of technology, with two principal assistants, appointed in 1907 and 1909, in charge of inland and marine fisheries respectively. Thus the development of fishery industry in its chief branches received simultaneous attention. A third assistant director for socio-economic work among fishermen and an oil chemist primarily for developing the soap industry were added in 1914. The latter post was subsequently transferred to the Industries Department. In 1919 a Marine Biologist was appointed and the first Marine Fisheries Laboratory was opened in 1921, but the post was abolished two years later. In 1923 a Master Fisherman was recruited from England for conducting off-shore fishing experiments with modern power boats and gear. He was subsequently designated Assistant Director (Marine). In the same year the Government of Madras called for a statement of policy and a detailed programme of research. It was decided to concentrate on problems concerned with strictly practical and economic ends and a programme for ten years was drawn up and approved by the Government. In 1924 on the bifurcation of the Salt and Abkari Department all the 107 fish curing yards of the Presidency with their complete staffs situated in the important fishing villages all along the coast were transferred to the Fisheries Department, thus giving the Department intimate touch with fishermen and the industry and making possible the collection of statistics and other valuable data, the introduction of improved methods and socio-economic work. In 1928 a special committee was appointed to enquire into the programme and achievements of the Madras Fisheries Department, and this Committee reported in great detail in 1929. They regretted that the large Government monopolies in pearl and chank, and the vested rights of Government in inland fisheries as well as the peculiar conditions of the fisher classes had necessitated concentration in the early years on revenue, administration and socio-economic work, rather than on scientific research. They recommended the appointment of a fishery biologist and eight assistant biologists, and the opening of two more biological stations. They also recommended the establishment of a freshwater biological station and a further staffing and equipment of the Tanur Experimental Station for technological research. Of these Government sanctioned in 1929-30 one assistant biologist and staff, including two research assistants, for the two existing biological stations at West Hill and Krushadai Island. In 1930 a fifth assistant director and staff were sanctioned for demonstrating and popularising fish culture in village ponds and tanks. This section, however, was abolished after a year on grounds of economy. In accordance with the recommendation of the Committee in Madras and that of the Royal Commission on Agriculture, the Imperial Council of Agricultural Research was approached for assistance for opening the freshwater biological station. Funds have been recently provided for this scheme. In 1932 with the sale of the trawler the post of Assistant Director (Marine) was abolished.

Since the close of the year 1938-39, the post of the Director of Fisheries has been abolished and the Madras Fisheries Department has now ceased to exist as a separate entity, becoming a section of the Industries Department under the Director of Industries and Commerce.

BENGAL. Investigations in Bengal started very early. Dr Buchanan Hamilton, a member of the Bengal Medical Service, carried on investigations on the fishes of the various districts in Bengal in 1784. In 1867 further enquiries were initiated and a most valuable and comprehensive questionnaire regarding the fish and fisheries of Bengal was issued. Again in the nineties of the last century, Lt.-Col. Alcock, I.M.S., made extensive enquiries into the coastal and estuarine fisheries of the Bay of Bengal during his tenure as Surgeon-Naturalist to the Marine Survey of India and later as the Superintendent of the Indian Museum. In 1906 the Government of Bengal placed Sir K. G. Gupta on special duty to enquire into the Bengal fisheries and as a result of one of his principal recommendations a Fishery Board for Bengal was constituted in 1909. To carry out a detailed survey of the marine fisheries in the Bay of Bengal a steam trawler, the "Golden Crown" was bought and Dr Jenkins of the Lancashire Sea Fisheries appointed to direct the work. In 1910 the Fishery Department was amalgamated with the Department of Agriculture. It may be mentioned that the department was a joint one for the Provinces of Bengal, Bihar and Orissa. In 1917 the department again achieved a separate existence, with a Director, two Superintendents and one assistant only to be again placed under the Director of Agriculture in 1920, and finally abolished in 1923. In 1932, Mr R. S. Finlow, Director of Agriculture, Bengal, after studying the conditions governing successful carp cultivation in Central Enrope and the progress made in fishery science in Madras by visiting the various centres of the Madras Fisheries Department, submitted a scheme for the re-organisation of the Fisheries Department in Bengal. No action seems to have been taken on his recommendations, but in November 1937 an Officer of the Madras Fisheries Department was requisitioned for a year to survey the position and make recommendations for the organisation of a Fisheries Department in the Province.

ASSAM. The early enquiries made in Bengal, of which mention has been made, covered also the fisheries of Assam. In 1917 a report on the fisheries of Eastern Bengal and Assam was published by Mr Kiran Chandra De, B.A., I.C.S., who was placed on this special duty. His report is very thorough and includes a survey of the fishery resources, methods of capture, transport, preservation and marketing, the social conditions of the fishermen and concludes with certain proposals, chief of which is the creation of a Fishery Board or Department of Fisheries. Certain remedial measures, such as the destruction of fish enemies, protection of brood and spent fish and of immature fish, the exploiting of hitherto untapped resources and socio-economic work among fisher classes are among the other matters discussed. Subsequently a candidate was deputed for training in Madras. At present no fishery investigation is in progress or is contemplated.

BIHAR AND ORISSA. The old Province of Bihar and Orissa had a fishery staff attached to the Department of Industries. On the bifurcation of the province, Bihar retained part of the staff, while Orissa has now imported an Inspector of Fisheries from Madras, pending the training of their own officer. Accordingly a graduate of the Calcutta University was sent to Madras for training for a year and his deputation to America for an academic course is under consideration.

BOMBAY AND SIND. Up to 1932 no complete or adequate account of the sea fisheries of the Bombay Presidency existed. The only publication which made any comprehensive attempt to deal with sea fisheries was 'the Report on the Improvement of Fisheries in the Bombay Presidency' published in 1910 by Mr W. H. Lucas, I.C.S. In 1917, Mr Mead, I.C.S., was deputed to study Madras fisheries and soap industries. From May 1921 to February 1922 the steam trawler 'William Garrick' carried out some experimental fishing and a report was published on the work of the trawler in 1923. Between 1910 and 1930 many changes occurred greatly affecting fisheries and fishery development and the knowledge fishery needs, and a new enquiry was instituted by Mr W. H. Sorley, M.A., I.C.S., at the instance of the Bombay Government. Mr Sorley's report was published in 1933 and embodies a separate enquiry, carried out by the Bombay Natural History Society into the condition of the shell fish industry of the Presidency, including Sind. The report does not claim to be a scientific enquiry in what Mr Sorley designates the 'narrower sense' of the term, but 'it does claim within its limits to give an accurate, up to date and practical account of the marine fisheries' in the Presidency. Following Mr Sorley's recommendations, the Bombay Government took steps to improve the supply of fish to the city of Bombay and to ensure its proper distribution. An Inspector of Fisheries was appointed in October 1933 under the Director of Industries and Commerce. The fish curing yards of the Presidency were transferred from the Salt Department to the Fisheries Section. In 1938-39 there were 32 such yards. The Fisheries staff have also started a programme of development of inland fisheries.

PUNJAB. A Fisheries Department was organised in the Punjab about 1914 and was placed in charge of a member of the Indian Civil Service. This newly established department set out to achieve a three fold object, viz. (1) to conserve all the species of fish then held by the rivers and tanks, through regulations of the method of fishing and the abolition of uneconomic and wasteful devices by fishermen; (2) to discover the habits and life-histories of the more important forms with a view to breeding them in captivity, and (3) to attend to the interests of the fisher castes and to bring back many to the trade of their forefathers.

In 1920 a young graduate was appointed as Fishery Research Officer. On the retirement of the Warden of Fisheries that post was abolished, and in 1934 the Fisheries Department was placed under the Director of Agriculture. The operations of the Department cover trout culture and inland fisheries.

CENTRAL PROVINCES. No fishery department exists in the Central Provinces and no fishery investigations are being carried out at present, but certain proposals of which the details have not been stated are now under consideration.

UNITED PROVINCES. A report (1923) on the fisheries of the United Provinces by Mr E. H. H. Edye, I.C.S., exists and a recent note by the Chief Conservator of Forests refers to the necessity for giving effect to some of the recommendations in that report, particularly steps to prevent the destruction of fish at the dams and weirs of canals. A trout hatchery was established at Bhowali, seven miles from Naini Tal in 1910. It proved that trout can be acclimatised to Kumaun. The Naini Tal lake was stocked. Another hatchery

at Kaldiani in Tehri-Garwal State was established in the Assi river on which the hatchery stands.

NORTH-WEST FRONTIER PROVINCE. No work on investigation of fishery problems is being carried out, but rules under section 6 of the Indian Fisheries Act, 1897 have been framed, and the Punjab Fisheries Act of 1914 has been extended to the Province.

KASHMIR. Kashmir has had the nucleus of a Fisheries Department for some time because of its interest in sporting fish, particularly trout.

BARODA. The history of fishery investigations in Baroda begins in 1909, when Mr James Hornell carried out a survey of the Marine Zoology of Okhamandel in Kathiawar. This resulted in the organisation of their Pearl Fisheries and two of the state officers were trained in Madras. Mr Hornell was again deputed at the request of the State Government in 1917 for a second investigation of the entire fishing industry of the state. It was not until 1936, however, that a department of fisheries was organised and Mr S. T. Moses taken from the Madras Fisheries Department to act as its Director from September 1937. The new Director has made a biological survey of the State and collected data. Several experiments have been carried out and various new schemes are now under the consideration of the State authorities.

TRAVANCORE. For many years Travancore has had a Fisheries section attached to their Department of Agriculture which was particularly interested in the fish curing yards and fishery schools established on the Madras model, the Inspector of Fisheries in charge as well as several of the teachers having been trained at the Calicut Fisheries Institute.

In 1936 the Fisheries branch was reorganised and placed under the control of a Superintendent, Mr A. Narayana Nair, who had recently returned after training in Japan and in Washington. At this time there were twelve fish curing yards in operation and 229 pupils in fishery schools. With the founding of the University in 1937, further interest in the development of the fisheries of the State was awakened. The University has a chair of Marine Biology and a doctor of science of London University has been appointed to it. The State has recently opened a Marine Aquarium which is also to serve as a marine biological station.

COCHIN. Like Travancore, Cochin has had a few fish curing yards and schools for some years and has deputed officers for training to the Madras Fisheries Department. About seven years ago, a local graduate was specially deputed to the Madras Fisheries Department for training and in 1939 he was appointed Superintendent of the State Fisheries, with headquarters at Ernakulam. The main concern of the Department is the administration of the extensive prawn fisheries of the Cochin backwaters and the control of the fish curing yards and schools.

MYSORE. About 1932 the Mysore Government began to take steps for the development of fisheries. A request for the deputation of the Director of Fisheries, Madras, to survey the field and plan their Department being refused, they asked in 1937 for the services of one of the trained officers of the Madras Fisheries Department. As this could not be complied with, they decided to send a lecturer of the Mysore University for training in 1939. After six months training in Inland Pisciculture in Madras, he was appointed Fisheries Officer in the State.

HYDERABAD. Hyderabad has been endeavouring to organise fisheries for a long time. As early as 1918, the services of the Assistant Director of fisheries (Inland), Madras, to survey the Osman Sagar, one of their largest irrigation reservoirs which had just been completed, were sought. Since then, the Director of Agriculture, Hyderabad has been experimenting with the farming of gourami and catla obtained from Madras. As these preliminary experiments did not succeed, H. E. H. The Nizam's Government decided to inaugurate a department of fisheries. The services of the Director of Fisheries, Madras, not being available, an assistant professor of the Oosmania University was deputed for six months training to Madras. The training is still in progress.

Research

Research on fisheries may be grouped under three heads (*a*) Marine Biology, (*b*) Inland Pisciculture, (*c*) Technological and Industrial Research.

A. Marine biology

MADRAS. The chief aim of marine fishery research is to find out approximately what the stock of fish in the sea is and what are the factors that govern the fluctuations in catches which have puzzled fishermen. For this reason the collection of statistics has always been an important adjunct to marine fishery investigation. No accurate figures of catches of sea fish except in Madras exist. Vague estimates have been made for India as a whole, for Bengal, and more recently for Bombay and Travancore. In 1918 some statistics of sea fisheries on the East and West Coasts of the Madras Presidency were published, and in 1917 and 1922 statistics for Tuticorin and Madras City were made available. It was not, however, until 1925-26 when the fish curing yards were transferred to the Fisheries Department that estimates of landings of sea fish and their value, and other cognate statistics were collected. Annual fish statistics for the West Coast have so far been published for six years ending with 1931. Subsequent statistics for the West Coast and similar statistics for the East Coast are in the course of compilation. In the *Review of the Trade of India* classified statistics are published yearly of the trade in fish and fish products.

The scarcity or abundance of natural food has an important bearing on the occurrence of any kind of fish and at the bottom of the food scale is plankton—the minute floating plant and animal life of the sea—which forms the food of several economic fish and indirectly the food of all denizens of the sea. Routine work at the two biological stations therefore includes the collection and rough analysis of plankton at frequent intervals. Plankton studies during the last five years have revealed :—

(1) The presence of sardine and mackerel eggs and consequently their breeding grounds and spawning seasons,

(2) a correlation between the growth of sardine and mackerel on the one hand and the abundance or otherwise of plankton on the other,

(3) the possibility of an intimate connection between rainfall and pearl fisheries in Palk Bay.

The collections of plankton have been carefully stored and are awaiting detailed study by a qualified planktologist.

Like all other living things, fish are affected by their environment. At both the stations temperature, salinity, pH etc. and conditions of the wind, weather and sea are regularly recorded. The rotation of fisheries in Palk Bay—the peculiar characteristics of the plankton of Krushadai Island have already shown the influence of hydrographical conditions of sea water on fisheries. The data, however, have to be collected for a series of years to correlate observations correctly.

In order that all facts affecting the stock of fish may be taken into account it is necessary to study the life-histories of food fish severally and collectively. The most important problem under investigation at West Hill has been the life-history of the oil sardine, which is the mainstay of the fishing industry of the West Coast. It is hoped that these investigations will finally result in an explanation of the seasonal fluctuations of sardine which have so great an effect on the fishing industry of the West Coast. Next in importance to the oil sardine is the seasonal fishery of the mackerel which is of great economic importance and also subject to great fluctuations. This fish has also been the subject of intensive study. Eggs have been obtained from the plankton which are almost certainly of the mackerel, while another important achievement is the detection of fish eggs among the stomach contents of this fish. If on future investigation the mackerel is found to feed on eggs of the oil sardine, or *vice versâ*, it might prove to be one of the causes of the natural fluctuation of these fisheries.

Similar studies have been attempted on other food fishes of the East and West Coasts at the two biological stations. The life-history of the food fish *Hemirhamphus georgii* (a half-beak) has been investigated.

The earliest marine fishery research was on pearl oysters. Pearl fisheries are peculiar to South India, except for a small fishery for inferior pearls in the window pane oyster in the Gulf of Cutch. Prior to the advent of the Madras Fisheries Department the most important report on pearl fisheries was by H. S. Thomas in 1884. From 1890-4 Thurston published three reports on the pearl and chank fisheries of the Gulf of Manaar. Hornell's report of 1907 is the next important record and since then pearl fisheries have come under the control of a technical department. The most important records of it are those which relate to (1) the pearl fishery at Tondi, (2) the irregular cyclic character of the pearl fisheries of the Gulf of Manaar (both in 1914), (3) a comprehensive report of all pearl fisheries of India in 1922, (4) the reports of the five fisheries held from 1926-1928 which gave the highest revenue of any pearl fisheries of which we have record. With the establishment at the Krusadai biological station of the pearl farm in 1932-33, intensive and successful pearl fishery research has been carried out. The best method of maintaining and breeding oysters in captivity has been discovered. Extensive studies on the age and growth rate of oysters as well as on the races of the Indian pearl oyster about which there are conflicting opinions have been made. Quite recently preliminary experiments in the production of cultural pearls have been started.

Chank fisheries, like pearl fisheries, are a crown monopoly, and yield a substantial revenue to Government. The line of research at Krusadai biological station aims at ascertaining the age, rate of growth, food and migration of chanks, about which little was known previously. Suitable tags were devised for marking young chanks and regular observations were begun in 1932. The

total number of chanks marked and liberated up to 1938-39 is 3,216. Of these 108 have so far been refished.

The Madras University Zoological Research Laboratory has investigated some fisheries problems connected with the food of fish, the life-history of some estuarine fish, fish parasites and plankton, since its establishment in 1931.

BOMBAY. No research work on marine fisheries is being done but some of the colleges are carrying on investigations on certain marine forms. The Karnataka College at Dharwar is investigating the helminth parasites of marine fish. The Wilson College, Bombay is carrying out a preliminary investigation of the fish of the Mahim Creek. At the Royal Institute of Science at Bombay, a study of the general problems of marine biology, such as the bionomics of marine coastal animals, plankton, and some edible fish is being undertaken.

BARODA. In 1909 and again in 1917 Mr Hornell of the Madras Fisheries Department made a study of and reported on the marine fishery resources of the State. Details have not been provided of the work now being carried on by the newly created Fisheries Department.

TRAVANCORE. The Professor of Marine Biology in the University and the Fisheries Section of the Department of Agriculture are responsible for marine biological research. No research of any importance appears to have been started.

B. Inland pisciculture

MADRAS. While compared with the sea, inland fishery resources are insignificant, it was realised that with care and culture they are capable of making a valuable contribution to the food of the province, especially as the vast inland population is at present cut off from any supplies of sea fish. For inland fishery development Japan offered the closest parallel with her rice fields, perennial and temporary waters and carp, mullet and eel as indigenous fish. The programme of development of inland fishery resources was accordingly planned on the Japanese model. The scheme of operation consisted of (1) establishing fish farms for breeding, rearing and collecting fry from natural sources for stocking rivers and tanks, (2) conserving existing resources wherever necessary (*a*) total prohibition of fishing in breeding reaches to prevent destruction of breeders and fry, (*b*) the prevention of poisoning and dynamiting and other destructive methods of fishing, and (*c*) the regulation of mesh and other methods of capture; (3) introducing exotic and improved varieties of food fish, and (4) ascertaining and popularising the best methods of fishing deep and perennial waters now unexploited.

Eight fish farms were established of which one primarily for breeding larvicidal fish for the Nallamalais was handed over to the Forest Department and the Mopad fish farm was closed as a measure of retrenchment in 1939. The fish farms are centres of breeding exotic food fish and for cultural experiments on indigenous and exotic fish. Among the results obtained in the fish farms may be mentioned a knowledge of the food, age, rate of growth of gourami, murrel, catla, etroplus, mahseer, megalops and trout; the best methods of breeding etroplus, hilsa and gourami; selection of the best fish for stocking;

methods of handling and transport of fry and fingerlings; and ways of eliminating murrel and other enemies from protected waters; as well as estimating the productivity of small tanks and large lakes. After the formation of a technical department of fisheries, the Government of Madras began a policy of gradually resuming control of the fisheries of major rivers and tanks which had been vested in the District Boards. The fisheries of the entire Cauvery river, thirty one large perennial tanks have been so acquired, while a systematic survey, district by district, of all major waters has been instituted, and the major fisheries of two districts have so far been taken over.

All destructive methods of capture have been banned under the Fisheries Act and a total prohibition of fishing enforced in certain breeding waters, the regulation of mesh in others. The most important fresh water food fishes of the Madras Province are Carp. The best of these were selected for each river system and their suitability for tank stocking was investigated by actual experiment in the fish farms. The fry of local carp is the hulk of the fish stocked to improve the fisheries of tanks. In addition the following new food fish have been introduced into the waters of the Province:

(1) rainbow trout (2) common carp and tench (3) catla from the north of the Province (4) gourami (5) etroplus and mullet from coastal waters and (6) mirror carp.

After several abortive attempts to acclimatise brown trout, Mr Wilson succeeded between 1905 and 1910 in establishing rainbow trout on the Nilgiris. The trout were introduced successfully on the Palnis in 1933 and a fishery having been established, licenses for fishing were introduced in 1936.

Hilsa is a large and esteemed fish which ascends rivers for breeding. Extensive and valuable fisheries exist in the Cauvery, Kistna and Godaveri. In order to protect the fish from possible extermination as a result of the building of anicuts which not only obstruct their passage but facilitate their destruction in enormous numbers by fishermen, a hatchery—the first of its kind—was established on the Coleroon river in 1909. From 1914 to 1921 the method of hatching hilsa eggs was determined but the equally difficult problems of rearing the fry until they are of sufficient size to be liberated safely into the river remains to be solved. Other field investigations have enabled the department to trace the life-history of the fish in the rivers.

The indigenous methods of freshwater fishing are even more primitive than those employed at sea, and experiments were begun in 1918 to devise methods of exploiting the fisheries of deep and perennial tanks. These were concluded in 1938. Drag and seine nets and basket traps were found unsuitable, gill and wall nets yielded good catches, dip nets were useful for catching bottom fish, while long lines were found suitable for freshwater shark and eel.

The great increase in rentals from the leased fisheries are a sufficient index to the success of the cultural operations conducted by the department.

In 1930 an Assistant Director and staff were sanctioned for propaganda for rural pisciculture but after a year the staff was disbanded on the grounds of financial stringency. The year's work, however, awakened considerable interest in pisciculture. A good deal of research is, however, required before ryots can be given all the help they require in growing fish, and the freshwater biological station now sanctioned should assist in establishing pisciculture as a cottage industry.

Another activity directly concerns public health by the control of malaria and other mosquito-borne diseases. This is done partly by the breeding and sale of larvicidal fish, partly by the periodic stocking of ponds in specially malarious districts and partly by the conversion of sheets of water into breeding ponds, where food fish as well as larvicide may be grown.

BENGAL. Except for some trawling experiments, almost the entire work of the Fisheries Department as such or as a section of the Agricultural Department from 1909 to 1933 concerned inland fisheries. The vested rights of zamindars over fisheries under the permanent settlement in force, combined with the absence of any fish farm or fisheries station, precluded any direct experimental work, and the department's activities were confined to statistical and marketing enquiries, laboratory work on fish, fish parasites and diseases and to the publication of descriptive reports on specific fisheries and allied industries. The artificial hatching of hilsa was attempted at Monghyr in 1911-13 and at Cuttack and Buxar in 1915 without success. Some useful observations on the habits of hilsa were, however, made. It was not till May 1936 that work was resumed by the Calcutta University with the help of the Imperial Council of Agricultural Research. A scheme for the investigation of the life-history, bionomics and development of freshwater fishes of Bengal has been in operation since that date. Four carp (Rohu, Calbasu, Mirgal and Catla) are being intensively studied in aquaria and in *jheels* with reference to their food, rate of growth and possibilities of culture. Some external characters of their fry measuring eight millimeters and more, the distinction between the sexes in Calbasu and Rohu, the aquatic flora and fauna on which they live were noted. The fry, fingerlings and adults were fed on artificial foods (cereals, pulses, soyabeans blood and meat) to ascertain their value. As the control fish in the *jheel* grew almost invariably better than those on artificial diet, no economic results accrued from these experiments. Attempts at artificial fecundation failed.

BIHAR. The activities of the Fisheries Section of the Industries Department are chiefly concentrated on the propagation and development of carp culture in tanks. The work is wholly of an economic nature. The regular collection of the fry of carp from the rivers and the stocking of tanks throughout the province is an annual feature of the work. In 1938-39 Government supplied 1,45,000 carp fry for stocking against 1,66,000 in the previous year at nominal cost to the public. They also distributed 3,000 larvicides for antimalarial work. An important research, however, was undertaken with the help of the Patna University to discover the causes for stunted growth of fish in certain tanks. The physics and chemistry of the soil and water were investigated and the stunted growth was ultimately traced by the Madras Fisheries Department, to which the problem was referred, to the use of a freshly made pond. Another important piscicultural experiment relates to the breeding of carp in confined waters of tanks, but the experimental farm opened for the purpose at Ghatsila in 1923 was abolished in 1932 on financial grounds. The experiments were planned on the lines of the well known carp hatcheries which have existed in the Chittagong district for many years.

ORISSA. No work on inland pisciculture is carried out except the collection and distribution of carp fry and propaganda for pisciculture in private and Government tanks.

BOMBAY. The development of inland fisheries on a commercial scale has engaged the attention of the Fisheries Section of the Department of Industries since 1935-36. A survey of suitable waters and local fish resources showed the absence of catla, which has given the best results elsewhere. Gourami were imported from Madras in 1936 and they bred in the municipal tank at Bandra in 1938. Another lot which was growing successfully at Kirkee died as a result of an epidemic. More than one consignment of catla fingerlings imported along with the gourami in 1936 had attained a length of two feet in 1938. There was no indication, however of their breeding. Some fingerlings obtained from etroplus originally introduced into a well at Vileparle were used to stock tanks elsewhere. As the fish are difficult to catch, a special trap was designed by the department. In 1937-38 for the first time cock-up (lates) has been experimented with for stocking inland waters. The natural supply of fry, however, was found to be uncertain. In 1938-39 three thousand five hundred young were collected and liberated into five tanks. The high cost of the fry and its limited and uncertain supply and its predaceous character seriously militates against the wider use of this fish for stocking purposes. An experiment with stocking ponds with murrel was made in 1938 but only 42 out of 225 fingerlings were taken in the following year. They had grown from three to nineteen inches. The greatest difficulty confronting the expansion of the experiments in stocking waters is the lack of supply of fingerlings.

At the Karnatak College, Dharwar, some fisheries work has been attempted on the distribution of freshwater fish in the Karnatak, the helminth parasites of fish and the breeding and distribution of larvicides. At St. Xavier's College bacterial diseases affecting fish have been studied. At Wilson College, Bombay, a preliminary investigation of the fishes of the Mahim Creek has been conducted.

PUNJAB. In the early years up to 1920 the work of the Fisheries Department appears to have been confined to trout culture. A flourishing and remunerative trout fishery has been built up. The annual stocking of streams with 60,000 to 80,000 ova and fry is carried out. Some diseases of trout have been studied and a qualitative and quantitative study of their food is in progress. The feasibility of acclimatizing brown trout in lower elevations in Madhopur and Gurdaspur is to be tried. Research on other fish such as Rohu began in 1920 when a research officer was appointed. At a fish farm at Chingwan and in other tanks carp culture as well as studies on the breeding and early stages of freshwater fish have been attempted. An interesting experiment is the attempt to cause ovulation of carp by the injection of pituitary extract which was successful through artificial fertilisation of the resulting eggs did not succeed. The discovery that the soaking of wheat straw causes fish mortality has also been made elsewhere. The growth rate of Mirgal and Rohu to 48 and 44 centimetres respectively in one year has been observed. The department also distributed fry for stocking tanks and ponds, an accepted method of improving inland waters. A suitable oxygen carrier for fish transport has also been devised. Larvicidal fish are also propagated and distributed by the department free of charge.

It is believed that fish farming has definite ecomonic possibilities, and in order to determine these, the fisheries staff was augmented temporarily for

three to five years. In 1938-39, as a result of the addition of research assistants work has begun in a number of directions.

The Punjab has provided fish ladders of the latest type at all but three of the irrigation dams on its big rivers at a cost of some lakhs of rupees.

UNITED PROVINCES. Special protective staff was employed in the Dehra Dun Forest Division at a cost of Rs. 1,400 and special rewards were paid for the destruction of others and crocodiles in the Kalagarh Forest Division. A considerable number of trout fry was distributed from the Gohna lake to suitable streams in Kumaun. Elsewhere the ordinary forest staff looked after the preservation of fish.

The Irrigation Branch did not sell the fish in its canals nor permitted them to be caught on a large scale except those in a few reservoirs in Bundelkhand. Fishing permits were, however, issued to amateur sportsmen. New fish ladders were provided in the weirs on the Ganges, Jamuna and Sarda rivers and the existing fish ladder at Hardwar was improved in order to permit larger fish to pass.

The fishing in the Kumaun lakes of Bhim Tal, Sat Tal and Naukuchya Tal was controlled by a Committee presided over by the Superintendent, Tarai and Bhabar Government Estates, and that in Khurpa Tal, which was stocked with Mahseer about twenty years back, by the Deputy Commissioner, Naini Tal.

HYDERABAD. Pending the creation of a fisheries department, the Hyderabad Government have been obtaining fish for stocking and advice from the Madras Fisheries Department.

MYSORE. The Vani Vilas Sagara was stocked in 1936-37 with 500 catla obtained from the Madras Fisheries Department. Public bodies as well as owners of private tanks have obtained advice and fish for stocking on various occasions from Madras.

TRAVANCORE. There are extensive and valuable prawn fisheries in the backwaters. Studies on these prawns have been made by the Fisheries Section of the Department of Agriculture. A primitive method of prawn culture in inundated fields is in vouge. A large revenue is derived from licensing prawn fishing.

COCHIN. The state derives the major portion of its fishery revenue from the leasing of inland fisheries, but little or no scientific work has yet been done.

C. Technological and industrial research

Fisheries represents a many sided industry of vast magnitude employing the principles and methods of many sciences chiefly biology, chemistry, mechanics and engineering. By fisheries technology here is meant the scientific processes applied in the modern fishing industry from capture through preservation and storage or manufacture of fishery products to transport, distribution and final utilisation of fish as food and its bye-products in medicine, art and industry.

The most important source of fish supply is of course the sea. India excluding Burma has a coast line of 4,800 miles. A possible limit to sea fishing with modern fishing craft is up to the 200 or 300 fathom line or more. Drift net and purse net fishing and long lining may extend much further. Only the

fringe of the sea is now exploited by Indian fishermen. What the fishing industry immediately wants for its expansion are (1) an accurate survey and estimate of the off-shore fisheries beyond the limit of the fishermen's present operations, (2) the determination of the best methods (craft and tackle) for Indian waters, (3) the improvement of indigenous and the introduction of new methods of handling, preservation and transport and (4) the development of markets. Except for the trawling surveys which have been carried out in Madras, Bengal and Bombay, Madras is the only province to carry on technological research on a comprehensive scale.

MADRAS. Some intermittent efforts in the survey of off-shore fisheries have been made. In 1907 two cruises by the trawler 'Violet' led to the discovery of an extensive trawling ground of 5,000 square miles off Cape Comorin and the Tanjore Coast. As trawling had been prematurely abandoned in the other provinces on account of its high cost, an effort was made in Madras when trawling was resumed in 1924 to combine other duties and so render the working of the trawler remunerative. A scheme was formulated to combine the duties of conveying white salt from Tuticorin to the West Coast for the fish curing yards which had just been handed over by the Government of India to the control of the Fisheries Department, the survey of deep sea fishing grounds, and the periodical inspection of the Laccadives, which are politically part of Madras. A second hand Admiralty trawler, 'Lady Goschen', was bought at a cheap price, but its damaged boiler escaped notice at the time and was a constant source of expense and delay. However, from the beginning of the survey in 1927 to the final breakdown of the boiler in 1931, when the trawler was sold, some valuable discoveries were made of important fishery resources. The results of the survey are embodied in two published reports while a third awaits publication.

The allied problem of ascertaining improved methods of sea fishing received more continuous attention. In 1909 two boats were built, one a sailing vessel of 12 tons and the other a motor boat of 24 tons, and experiments were conducted, but it was found that the boats were too big for small work and were not big enough for large work. It was also found impossible to secure a crew who on their own initiative and without expert supervision would work and modify methods as occasion required in unknown and untried conditions. Pending the recruitment of a European master fisherman which was not possible during the last war, two Ratnagiri boats (sailing drifters of 6 to 8 tons) were hought in 1916 and the experiments were continued until 1920, these boats being able to stay out several nights at sea, but for the same reason these also were found unsatisfactory. From 1917 to 1921 Malabar canoes and nets were tried at Madras and Negapatam, but their superiority over the East Coast catamarans was not sufficiently proved. On the experience gained, the problem of lack of harbours, heavy surf and the capacity of the local fishermen to adopt new methods were reviewed and a Yorkshire motor coble was decided upon as a distinctive craft designed to work in conditions verv like those prevailing ir South India. Unfortunately the arrival of the coble almost coincided with the breakdown of the trawler's boiler, and the termination of the master fisherman's appointment, and so no experiments have been possible with the coble. After a long and careful survey of all existing types of vessels, negotiations were opened for the services of a Diesel-engined Danish fishing vessel, with a

master fisherman experienced in tropical waters, but the outbreak of the present war unfortunately brought these to an abrupt conclusion.

Fish refrigeration. Large areas beyond a distance of about 25 miles from the sea coast have no means of obtaining fresh fish, though a large potential market exists. Refrigeration as the only means of supplying the demand was the subject of early enquiry by the Department. From 1913-1916 freezing fish in ice and by the Henderson method were tried successfully. Fish frozen and packed in paddy husk travelled successfully up to two days by rail. The experiment was abandoned owing to cost. In 1928 a simple method was devised of using an ordinary ice-making plant, which avoided on the one hand the payment of heavy royalties and the locking up of capital in machinery which could not be used for any other purpose if the venture should fail, and also the need for skilled mechanics to operate the machinery. In 1928 the first fish refrigeration factory in India was built at Malpe. This factory worked successfully for three years, when it had to close down on the adoption of the provincial motor tax, which made the only method of transport for the output of the factory too expensive. There are still many improvements possible in this simple method which can only be determined by research at a Government station.

Fish canning. A cannery for experiment and demonstration was sanctioned in 1908 and first set up in Cannanore in 1910-11. In 1911-12 it was transferred to Calicut and in 1915 to Beypore. Hundreds of experiments were made but war conditions hampered operations as tin plate and other stores were expensive. However a high degree of technical success was obtained and an appreciative market was found for the various products. By 1920-21 the post-war slump and foreign competition began to affect the trade, though the cannery continued to work until 1925 when operations were suspended. Stocks were cleared by 1926-27. The Government decided to sell the concern to a private individual, and the cannery was accordingly sold to Mr Krishnaswami Nayudu in 1933 for Rs. 6,000. He has since invested nearly three lakhs on new machinery and buildings.

Fish curing. Cured fish is of great importance in the undeveloped condition of transport and trade in the Madras Province. The Indian curing industry lacks almost everything to be desired in the methods of handling, preservation and distribution of fish and fish products. The Fishery experimental station at Tanur has been working since 1912 for the improvement of indigenous curing and preservation methods, and for the introduction of up-to-date processes and new industries that are inexpensive to adopt. The most important researches conducted at this station relate to methods of cure, manufacture of oil, guano and meal, and the preservation of craft and tackel. To enable the methods thus elaborated at Tanur to be popularised, six public fish-curing yards were first taken over from the Salt Department in 1919. The result has been a great improvement in the appearance and other qualities of the salt fish produced, an increase in the export trade with those places which appreciate a superior article, and the general raising of the market standard. Other results obtained are a method of pickling fish in casks which enables it to be taken out and sundried after storage and an improved method of salting and sundrying prawns which is highly appreciated by the market, but these have not yet been adopted generally by the fishermen.

Another line of investigation in Tanur relates to the storage of cured prawns in carbon di-oxide and the process finally adopted is now regularly employed at Tanur and has resulted in an increased trade in this article throughout the year instead of only during the prawn season. Indian prawns have also been successfully bottled at Tanur and are equal to the European and American packs in appearance and taste.

Artificial dryer. The prawn fisheries of the Province are worth several lakhs of rupees but as they coincide with the South-West monsoon, drying of prawns has always been a problem and prawns worth a large amount are lost every year. To solve the difficulty Sir F. A. Nicholson devised an artificial dryer in 1913-14 but the dryer did not work properly until 1928. On account of the expense involved and the mechanical skill required for its operation, the type of dryer used in Europe and elsewhere is unsuitable for present Indian conditions. An attempt was made therefore to devise a simple automatic dryer which would utilise the convention currents set up by the fire chamber for control of temperature and dryage. Although some of the problems have not been completely solved, the dryer has now reached a satisfactory working stage.

Preservation of boats and nets. The cost of boats and nets represents practically the entire capital investment of the fishing industry in the Madras Province. Annual depreciation is disproportionately large compared with the earnings of the fishermen. The preservation of nets has engaged the attention of Tanur since 1923. Various recipes for treating nets have been tried with some success. The latest methods recommended by the Bureau of Fisheries, United States of America are now awaiting trial at Tanur. For the preservation of craft, an 'Ascu' wood preservation plant has been set up at Tanur. As an experiment one log out of a new catamaran owned by a Madras fisherman was 'Ascu' treated on 19th October 1933 and has been under observation until now. It is still free from surface deterioration, while its sister logs have had to be replaced.

Experiments with a simple diving dress for pearl and chank divers. Diving of the old style as a profession is now dying out and recruitment of divers is a constant problem in conducting pearl and chank fisheries. Regular diving with full dress was tried in 1887 but the results were so discouraging that the idea was abandoned. Pearl divers in Japan, however, use a much simpler device, while students of marine biology in America also have a simple form of apparatus. A Japanese facemask with compressed air cylinders was bought in 1927. Good results were obtained with this, and certain modifications which have subsequently been introduced give grounds for the belief that it will be possible to extend the under water time of the diver to half an hour, instead of the customary fraction of a minute of the naked diver.

Fish oil, fish guano and fish meal. Prior to the experimental work of the Madras Fisheries Department in 1908, some sardine oil of inferior quality was produced on the West Coast and used for smearing boats and as a cheap luminant. Its many industrial uses and the value of its by-products were quite unsuspected. Similarly the fish guano produced was equally poor both in quality and quantity. The experiments made by the department had swift and unexampled success. It was found that a quite simple plant could separate the oil and fertiliser, improving the quality and therefore the value of both,

and soon as many as 647 private factories came into existence on the model of Tanur, manufacturing in a favourable season, fish oil and manure worth nearly half a crore of rupees. The Malabar oil has since been found useful in all kinds of industries, too numerous to mention here. The phenomenal advance of oil chemistry and technique opens up many more avenues of even greater profit and usefulness, and further advance research is necessary for which there is neither equipment nor staff. The guano or fish manure is still capable of improvement both in the quality of the manure itself and in the utilisation of by-products now wasted. Such processes still await investigation at Tanur.

The manufacture of fish meal as a food for farm stock is a very recently established industry. The experiment of Sir F. A. Nicholson up to 1921 led him to conclude that the manufacture of fish meal was not possible in this country. However, subsequent experiments at Tanur have shown that a fish meal of very good quality can be manufactured, and already the local demand has increased to such an extent that Tanur is nnable to meet it, while there is also a big demand from abroad. Many details in the manufacturing process still need attention, by which production costs could be lowered and the appearance and quality of the meal improved.

A recent development in the fish manure industry is the use of sea weed, in combination with fish refuse as manure. Though the services of a biochemist would be invaluable, the processes seem to be sufficiently simple for initial experiments at Tanur. The mixture hitherto made has been found to revive weak or dying coconut trees and has been used with great success on the coconut plantation at Krusadai and elsewhere. Enquiries were made with a view to develop the manufacture of kelp and iodine from Indian sea weeds, but the analysis so far made of the sea weed from Pamban did not show enough iodine for it to be worth extracting. However all the commoner weeds will have to be examined before the research is abandoned, and for this also a chemist is needed.

Medicinal fish liver oil. The manufacture of medicinal fish liver oil is the latest development of technological research at Tanur and this has a promising future. In Sir F. A. Nicholson's time a first class sardine oil was placed on the market, but in 1928-29 it was found by actual test that it contained no vitamins. A search therefore for fish oils of Vitamin A potency was begun with the collaboration of the Director, Nutritional Research Laboratory, Coonoor. More careful methods of manufacture gave sardine oil with about 25 per cent of the vitamin A potency of cod liver oil. Since then, of the 34 common kinds of sea fish tested, several have been found to yield liver oils 2 to 35 times as rich in vitamin potency as commercial cod liver oil and one as much as Halibut liver oil. In 1939 Government sanctioned a scheme for initiating the manufacture of fish liver oil as a cottage industry. Since the close of the year, the outbreak of war and the consequent scarcity of cod liver oil gave rise to an urgent demand for the oil from the medical profession, both for war and civil services, and the Madras Government have introduced a scheme for manufacture and sale on commercial lines and placed it in the charge of the Superintendent of the Kerala Soap Institute under the Director of Industries, Madras.

Scheme for advanced research. As shown already, in most lines of technological research the need for a better equipped laboratory and fully qualified

chemist has been felt for over ten years. A detailed scheme for advanced research on fish manure, fish oil and fish meal arising out of a report which the Imperial Council of Agricultural Research had obtained from the Director of Fisheries, Madras in 1931 was considered by the Council, but has had to be postponed on account of the war.

BENGAL. Reference has been made to the survey of the Bay of Bengal fisheries by the Trawler 'Golden Crown' in 1908-09. In 1921-22 a student from Bengal was trained at the Tanur station in improved methods of fish curing and manufacture of oil and guano.

ASSAM. In 1934-35 a student from Assam received training in the Fisheries Training Institute, Madras.

BIHAR AND ORISSA. In 1925 the Superintendent of Fisheries, Bihar and Orissa studied working methods at Tanur, and was later supplied with the plan of the smoker and dryer at Tanur. In 1938-39 three students from Orissa came to Madras for training at the Tanur station.

BOMBAY. Bombay was the third province to survey its off-shore fisheries by trawling. A full sized steam trawler 'William Garrick' well found and fully equipped with a scientific staff carried out trawling experiments from May 1921 to February 1922. The same year a student from the Victoria Technical Institute, Bombay, came to Madras for training at Tanur in methods of oil refining, oil extraction, etc. The middle of October 1933 saw the appointment of a Fisheries Inspector and a definite plan of work designed in the first place to improve the supply of sea fish to the great population of the city was prepared. It was decided to hire in the first place a motor launch from the Royal Indian Marine to act as a collecting vessel, and if the experiment succeeded to buy or build two suitable vessels to be sold to the fishermen on the hire purchase system. The newly appointed Inspector of Fisheries was to demonstrate the new methods. It was also proposed to train apprentices in driving the power boats so that if the scheme found favour with the fishermen and they decided to convert their sailing boats into power boats, they would not have to depend upon paid drivers.

The scheme proved so successful that by the end of 1934 a third vessel had been launched. In 1934-35 two motor launches were bought and sold to fishermen on the Hire Purchase system. No new launches were built during 1936-37, partly because it was thought desirable to recover a good proportion of the outstanding dues from the fishermen, and partly because the extension of the field of their operations made it advisable to collect data regarding the efficiency of the present engines. The number of launches, however, is still increasing. In 1938-39 Government used four and private individuals maintained five launches. Suitable apprentices are being trained as drivers.

Experiments are also in progress to improve the yield by the use of better types of nets. One result of the operations of the launches is the establishment of an ice factory at Chendia, a port in the Karwar district. This is the second Ice Factory to be established on the coast. There are also two cold storage plants in the city of Bombay.

The control of the fish curing yards was transferred from the Government of India to the Fisheries Section in 1936 so that the technical advice and the guidance of the fisheries officers might be available for the curers. Efforts are being made to induce curers to resort to the yards and comply with the hygienic

methods of curing. In 1938-39 two Fisheries Officers came to Madras for training at Tanur.

BARODA. In 1917, Mr Hornell, then Government Marine Biologist in Madras, was deputed to Baroda to make a second investigation of the fishery resources of the State. He found the pearl fishery developing on the lines recommended by him ten years previously, and made a number of recommendations for the improvement of sea fisheries in the State. The two fishery officers of the State had received their training in Madras.

In 1922 the State asked for advice from Madras in regard to establishing experimental canneries. It was arranged to supply can hodies and covers for preliminary operations. The department of fisheries has recently been completely re-organised, and schemes for an industrial depot for cold storage and curing and a similar cold storage depot at Okha are under consideration.

TRAVANCORE. From 1921 onwards the Travancore State has been sending students almost every year to the Fisheries Training Institute of the Madras Fisheries Department. As long ago as 1921 the Travancore Government was interested in fish canning, and asked for advice from Madras, where the Fisheries Department was then operating the experimental cannery. In 1935-36, when a new Superintendent took charge of fisheries, Government sanctioned the installation of a cold storage plant.

At the same time experiments were started to develop a process for the extraction of shark liver oil fit for medical use as a cottage industry. The possibilities of manufacturing insecticidal soaps, candles, etc. from fish oils were also made the subject of investigation. These investigations proceeded slowly on account of the lack of trained assistants. During 1938-39, the subversive political movement retarded work in the cold storage and impeded the sale of frozen fish in Trivandrum. The Fisheries Superintendent therefore visited a number of villages and fish markets with a view to creating a demand for the frozen fish from the cold storage at Trivandrum. He also devised a method of packing and transporting fish to distant markets without impairing its quality.

Twelve fish curing yards are controlled by the Fisheries Section of the Agricultural Department in Travancore.

A few other institutions which have done technological work in fish oils and fishery products are (1) The All India Institute of Hygiene and Public Health, Calcutta, (2) The Nutritional Research Laboratory, Coonoor and (3) The Indian Institute of Science, Bangalore.

CHAPTER IX

VETERINARY AND ANIMAL HUSBANDRY RESEARCH*

1. Disease Control

(a) Bacterial and virus diseases

THE incidence of epizootics caused by bacteria and viruses, and the losses incurred during these were greater than in the previous year. The losses reported amounted to 2,12,400 as compared with 1,75,100. (These figures are only approximate and refer to British India only). In general the North and West reported fewer outbreaks. In the South, Centre and Bengal the position was unchanged or slightly improved while Bombay, United Provinces, Orissa and Assam reported increases in the number and severity of outbreaks as compared with last year.

These increases were in most cases attributed to the lack of legislation for the restriction of movement of animals from and to affected areas and it is clear that in the absence of Veterinary police regulations complete control cannot be established, and attempts at control by preventive inoculations are largely nullified. In some provinces action has already been taken to amend the position and during the current year the Central Provinces opened nine quarantine stations for the control of migrating cattle. In other cases the increase in the number of outbreaks reported is said to be due to the introduction of improved systems of reporting. In many areas there is, however, still room for much improvement in this respect.

The assistance of the Veterinary Investigation Officers, who are maintained by a grant from the Imperial Council of Agricultural Research, in diagnosis and the supervision of control measures, was again a notable feature of the year's work and the interest aroused in the investigation of the diseases of sheep, goats and poultry was extended.

1. *Rinderpest.* As usual, outbreaks of this disease were widespread throughout the country, with the exception of Baluchistan and Travancore which were

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1. Mr J. R. Haddow, B.Sc., M.R.C.V.S., D.V.S.M., I.V.S., Officer in charge, Pathology and Bacteriology Section, Imperial Veterinary Research Institute, Mukteswar.
2. Dr H. N. Ray, M.Sc., Ph.D. (Lond.), Research Officer (Protozoology), Imperial Veterinary Research Institute, Mukteswar.
3. Dr G. D. Bhalerao, D.Sc.(Allah.), Ph.D., F.Z.S., F.R.M.S., F.A.Sc., Research Officer (Helminthology), Imperial Veterinary Research Institute, Mukteswar.
4. Rai Bahadur S. K. Sen, B.A., M.Sc., F.R.E.S., Research Officer (Entomology), Imperial Veterinary Research Institute, Mukteswar.
5. Dr N. D. Kehar, M.Sc., Sc.D., Research Officer (Physiology), Animal Nutrition Section, Imperial Veterinary Research Institute, Izatnagar.
6. Dr P. E. Lander, M.A. (Cantab.), D.Sc.(Lond.), Principal, Agricultural College, Lyallpur.
7. Mr E. J. Bruen, O.B.E., I.A.S., Livestock Expert to Govt., Bombay Province, Poona.
8. Capt. U. W. F. Walker, M.C., M.R.C.V.S., I.V.S., Director of Veterinary Services, Punjab, Lahore.
9. Mr P. N. Nanda, M.R.C.V.S., Superintendent, Government Cattle Farm, Hissar.

reported to be entirely free. The number of death reported was 117,400 as compared with 89,700 last year.

Particularly severe infections were reported from Assam, United Provinces, Orissa and Mysore and increased incidence has also been reported from the Central Provinces and North-Western Frontier Province, but the attacks were not so severe as in the previous year. There was a notable reduction in Sind.

As a measure of control, the use of Mukteswar goat adapted virus, with in some cases a small dose of serum simultaneously, was practically universal and with few exceptions, which have all been individually investigated, it has been favourably reported upon as a means of gaining rapid control of an actual outbreak. Its efficacy in this respect would appear to depend on the simultaneous application of measures to reduce or control movements of susceptible animals in the affected areas. The scheme in the Central Provinces financed by the Imperial Council of Agricultural Research for the investigation of this method as a satisfactory means of control was brought to a successful conclusion during the year.

Research work was carried out in Madras and Bombay on conditions which affect the period for which the vaccine remains efficacions and attempts were made to extend this. In the United Provinces efforts were directed to obtain a modified preparation of less virulence than the normal goat adapted virus. Outbreaks of considerable severity in sheep and goats were reported especially in Madras and Ajmer Merwara. In these animals serum simultaneous inoculation is the only method of control recommended. The economic importance of this disease in these animals is by no means negligible.

2. *Hæmorrhagic Septicæmia.* This disease occurred throughout India and the incidence was in most cases greater than in the previous year particularly in the United Provinces. The mortality reported was 54,900 as compared with 45,390 in the previous year.

The popularity of vaccination for the control of the disease is increasing although the common practice is to attempt control by the use of antiserum at the seat of outbreaks and vaccine in those areas which are known to be affected annually. It is reported that better results are obtained when the vaccine is made from virulent strains of the organism.

The Central Provinces report that considerable economy and greater efficacy can be effected if the administration of vaccine is limited to the period just before the onset of the monsoon as the effective immunity conferred is limited to about two and half months.

Further investigation of the epizootiology of this disease is required.

The disease has also been reported in sheep.

3. *Blackquarter.* The mortality reported from this disease was 21,600 as against 19,200 in 1937-38. The disease occurred throughout the country but was particularly severe in Bombay, United Provinces, Bihar, Madras and Mysore.

Vaccination in enzootic areas is becoming increasingly popular as a means of control.

4. *Foot-and-Mouth disease.* The incidence of this disease was not much altered from the previous year but outbreaks were milder and the total mortality recorded was only 4,600 as compared with 7,400 in 1937-38. There was a reduction in Assam, Bengal and North-West Frontier Province but an increase

in Central Provinces and Madras. Sheep and goats were also affected. In the North-West Frontier Province antiseptic foot baths are stated to have had a measure of success in reducing the spread and mortality in this condition. During an outbreak in the herds of the Northern Circle, Military Dairy Farms, of the adult stock, all imported and Indian Friesians contracted the disease, but with the entry of indigenous blood the incidence fell to 12-31 per cent. Only six per cent of adult buffaloes contracted the disease. The percentage of young stock attacked was greater, all breeds with foreign blood being 63-100, with indigenous breeds 23 and young buffaloes 50. There were no deaths.

5. *Anthrax.* The position with regard to this disease remained practically unchanged. The recorded mortality was 8,287 against 7,642 for the previous year. Madras, Mysore and Assam were chiefly affected. The Punjab had no case during the year. There were also very few cases in cattle in the North-West Frontier Province, Baluchistan and Sind but there were numerous cases in sheep and goats in these provinces. There were also numerous outbreaks in sheep and goats in Madras and Bombay. The use of spore vaccine, obtained from the Imperial Veterinary Research Institute, Mukteswar, as a preventive has been extended with apparently satisfactory results. It has also been tried at the scene of actual outbreaks.

6. *Tuberculosis and Johne's Disease.* The incidence of tuberculosis is now under investigation in most of the provinces but there is as yet no information as to the loss caused through this condition. A serious increase in the number of reactors to double intradermal tuberculin test at the Government Cattle Farm, Hissar in the Punjab is reported and its occurrence in the Madras Corporation bullocks is also noted.

The position is similar in regard to Johne's disease but systematic investigation appears to be confined to Assam and Mysore. At the latter place a detailed investigation subsidised by the Imperial Council of Agricultural Research has been prosecuted since 1935.

A few cases of the occurrence of this disease in sheep have been noted and artificial transmission of the disease to these animals has been confirmed in work carried out under the scheme mentioned above.

7. *Brucellosis.* This disease was reported to be under investigation in Bengal, United Provinces and Madras but no figures regarding incidence are available. A specialist officer was appointed to take charge of the scheme for the investigation of contagious abortion under the auspices of the Imperial Council of Agricultural Research but he was unable to join the appointment in the year under review.

In the herds of the Northern Circle, Military Dairy Farms the incidence of this disease was greatest (8-27 per cent) in the imported and Indian Freisian grades, 1-6 per cent in other grades, and less than one per cent in indigenous cows and buffaloes.

8. *Sheep-and goat-pox.* The mortality reported under this head was 1,908 as compared with 3,380 in the previous year but there is no indication that the reduction in mortality was accompanied by any reduction in incidence. Madras, North-West Frontier Province and Baluchistan were most heavily affected.

The disease was controlled either by ovination or by vaccination (glycerinised powdered scab) and the results are reported to be fairly satisfactory.

9. *Rabies.* It is still difficult to form any opinion on the incidence and importance of this disease. The reported mortality amongst dogs either by death or destruction was 1,146 against 690 in the previous year. The increase is clearly due to better reporting, but there are still large areas from which no figures are available. The reports indicate that the administration of anti-rabic treatment for suspected cases is on the increase and although mainly performed on dogs has been extended to cattle, horses and even elephants.

10. *Glanders.* The country would appear to be remarkably free from this disease as only between 30 and 40 cases, of which 21 were in the Punjab, were reported.

11. *Poultry diseases.* Although this subject is undoubtedly receiving much more attention than hitherto, there is still little information as to the incidence or mortality caused by even the well known diseases. Fowl cholera was noted in most provinces but was not severe and was readily controlled either by serumisation or vaccination. Fowl pox was noted in four provinces but did not appear to be severe, and Ranikbet disease was apparently not a source of great loss except in Bombay and Madras. Other diseases are not mentioned but Mysore reports the occurrence of contagious coryza, fowl typhoid, bacilliary white diarrhoea and all forms of leucosis indicating that active steps should be taken to ascertain whether these diseases are widespread and, if not, to localise them.

In addition to the diseases listed above, several others have been noted in different species of animals. Of these the most outstanding is 'Contagious pleuropneumonia' of sheep and goats. It is probable that the affections included under this term are not all of the same origin, and although the reported mortality fell from 2,178 in 1937-38 to 826 in the present year, the condition is of much greater importance than these figures would imply.

The reported occurrence of Heart-water in imported sheep in Mysore indicates the necessity for legislation to prevent the importation of this and similar diseases.

Other diseases noted were strangles and influenza in horses, distemper in dogs and ephemeral fever in cattle, the incidence of the last two being on the increase.

(b) *Protozoology*

Trypanosomiasis. In the Protozoological Section of the Imperial Veterinary Research Institute, Mukteswar, observations were made on the behaviour *in vitro* of surra trypanosomes of equine and bovine origin. It was noticed that within 72 hours most of the trypanosomes had entered the mononuclear cells and has assumed a round form. The free flagellate forms had become immobile and showed signs of degeneration. This culture when inoculated intravenously into rabbits produced surra in these animals after an incubation period of ten days. Whether the infection was caused by the round form or by trypanosomes, which, although apparently degenerating were still viable *in vitro,* is difficult to answer at this stage of the inquiry. The experiments are, however, being continued with a view to clearing this point. Reports of fatal outbreaks of surra amongst cattle having been received during recent years from a number of provinces in India and at least one Indian State (Hy-

derabad-Deccan), the Institute was called upon to enquire into the factors under which, *Trypanosoma evansi*, which is believed to be normally innocuous for the bovine species, attains the status of a virulent variant for the animals. The extent of severity which this disease is liable to assume is illustrated by the fact that instances are on record where death has occurred in the course of a few hours following the appearance of the first symptoms. An obvious desideratum in connection with this problem was the exclusion of the possibility that the parasite involved in acute cases of bovine surra was referable to a species other than *T. evansi*. A study was therefore undertaken to define in the first instance the morphological relationship between the trypanosomes of equine origin in one hand and those of bovine origin on the other. A comparative morphological study of those two groups of trypanosomes by statistical methods was made on the same lines as described by Hoare and Broom (*Trans. Roy. Soc. Trop. Med., & Hyg.*, 1938, **31**, 517-534) for determining the systematic position of *T. uniforme* and *T. vivax*. Bio-metrical studies carried out so far have shown that the equine form of trypanosome is smaller in size than the bovine one; on the other hand, the camel surra parasite has been found to correspond with the equine one in length. This inquiry was still in progress at the end of the year under report.

In the Madras Province 356 reports, as against 72 in the previous year, of surra amongst bovines were received during the period under review, the most severely affected centres being the districts of North Arcot and Chingleput. In the latter district one buffalo also showed numerous trypanosomes in its blood. A total of 3,099 animals were subjected to either prophylactic or curative treatment with Antimonium tartaratum in the district of North Arcot alone. Fifty outbreaks of surra in equines have also been reported from this Province and it is stated that the disease was confirmed in 102 ponies of which 18 were destroyed after paying compensation and the remaining 84 were successfully treated with Naganol. From the Bombay Province, cases of both equine and bovine surra have been reported. Of the 64 ponies treated with Naganol, 5 died and the rest recovered, while 139 cattle and 12 buffaloes are reported to have died of this disease. In the Province of Bengal, 98 deaths due to surra in equines have been reported from Dacca. In 22 districts of the United Provinces of Agra and Oudh, 515 cases of surra in camels and equines were treated. 137 deaths, as against 162 in the previous year, occurred amongst bovines belonging to 9 districts of the province. The highest number of deaths recorded was 81 in Gorakhpur district. Experiments designed to ascertain the single minimum dose of Naganol as a prophylatic against surra in equines were continued again this year and it was found that a single dose of 1 grm. of the drug gave protection against surra to horses and mules during the surra season, this being in accord with the previous year's findings. In the Punjab there were 44 surra centres at work during the period under review as against 50 in the previous year. The total number of cases treated at these centres was 2,526 against 3,908 in the preceding year. This number included over 1,500 camels and over 1,000 equines. The most affected centres were the districts of Sheikhupura, Gurdaspur and Gujranwalla. In the Central Provinces and Berar 64 outbreaks amongst bovines, as against 25 in the previous year, were recorded with a mortality of 131. 50 cases were confirmed microscopically and treated with either Naganol or Tartar emetic with satisfactory results.

In the same Province 56 outbreaks in equines, as against 71 in the previous year, were reported with a mortality of 93, as against 82 in the previous year. The disease was found to be more prevalent amongst equines in the Berar division where the presence of trypanosomes was confirmed microscopically in 116 cases and all were treated successfully with Naganol. In Assam only two deaths due to surra occurred amongst bovines, while 104 deaths in six districts occurred amongst equines. In Sind surra in equines was recorded from Karachi, Hyderabad and Thar Parkar districts. It is reported that 121 horses were attacked and that of these 90 were successfully treated with Naganol, 2 destroyed and 29 died untreated. 30 cases of camel surra were also reported from this Province and of these 9 died in the Thar Parkar district while the remaining 21 were successfully treated with Naganol. Cases of surra in camels and horses were also reported from Ajmer-Merwara during the period under report. In the North-West Frontier Province three fatal cases of equine surra were reported, as against six cases and four deaths in the preceding year. It is reported that animals failed to respond to treatment as they were brought for treatment in an advanced stage of the disease. An outbreak of bovine surra was reported from Kurram Agency and also a sporadic case in a buffalo in Kohat district. In the Hyderabad State 26 cases of surra in equines, 4 in bovines and one in dog were reported during the period under review. A buffalo showing *Trypanosoma theileri* was also recorded in this State. One fatal case of bovine surra was reported from Coorg, while five deaths in equines due to the same disease were recorded from Baluchistan. In Mysore State 97 milking cows in Dinsaw's Estate were affected with surra but all were treated successfully with Naganol.

Theileriasis in cattle. During the period under review, further observations were made in the Protozoological Section at Mukteswar on the morphology of the virulent form of Theileria parasite, tentatively designated as *T. annulata.* Towards the end of the year under review, the treatment of experimental theileriasis, with members of the Sulphanilamide group of drugs was undertaken and the results are awaited. In Hyderabad State 44 cases of theileriasis were confirmed of which 42 showed infection with *T. mutans* and two with *T. annulata.* In the Province of Assam theileriasis has been reported to occur amongst calves of between one and six months in age. No Koch's bodies were seen in the blood smears made from the diseased animals and the causative agent is stated to be *T. mutans.*

Theileriasis in sheep and goats. During the period under review cases of theileriasis in sheep were reported from Kolar in Mysore and from Sind and Ajmer-Merwara.

Babesiasis in cattle. In the Central Provinces and Berar 440 cases of bovines as against 437 in the previous year were recorded. In Assam 9, in the United Provinces of Agra and Oudh 8 and in Coorg 2 cases of bovine piroplasmosis were recorded during the year under report. In Shikaripur taluk of the Mysore state there appeared a severe form of haemoglobinuria amongst cattle following an attack of rinderpest. This, it is reported, was due to a concurrent infection with *Babesia bigemina.* A virulent outbreak of piroplasmosis due to infection with *B. bigemina* occurred in dairy cows—especially in the Hariana cows recently imported from the Punjab—of the Agricultural Institute, Dacca, Bengal.

Babesiasis in sheep and goats. In the Protozoological Section at Muktes war a new species of Babesia (*B. foliata*) was found in the blood of a sheep that had been subjected to blackquarter vaccine test at the Institute. A detailed article on this subject is now being prepared for publication. In Mysore State a severe outbreak of Babesiasis appeared among the merinos that had been recently imported from South Africa. It is reported that out of a lot of 31 animals (19 ewes and 12 rams), 18 (9 ewes and 9 rams) or nearly 60 per cent, died and the remaining 13 (10 ewes and 3 rams) or 40 per cent survived. It is presumed that this survival was due to the intervention of the drug Acaprin.

Babesiasis in dogs. Cases of babesiasis due to infection with either *B. canis* or *B. gibsoni* or both were reported from the Central Provinces and Berar, Mysore State, Hyderabad (Deccan) and Assam. In the Central Provinces cases of infection with *B. canis* were treated with Trypan blue and Acaprin, while in cases of *B. gibsoni* infection the drug employed was Tryparsamide. In the Mysore State 0·5 per cent solution of Acaprin was found suitable for the treatment of *B. gibsoni* infection in the field.

Toxoplasma canis infection in a dog. In the Protozoological Section at Mukteswar a pure bred spaniel after its death due to experimental infection with *B. gibsoni* revealed in its organ smears the presence of *Toxoplasma canis*. This would appear to be the second record of the occurrence of this organism in India. A detailed article on this subject has been submitted for pnblication in the *Ind. Jour. Vet. Sci. and Anim. Husb.*

Babesiasis in horses. During the period nnder review four cases of infection with *Nuttallia equi* from Hyderabad State and four from Sind and Ajmer-Merwara were reported; while one case of infection with *B. caballi* was also recorded from the latter province.

Coccidiosis in bovines. In the Province of Madras 115 cases, as against 181 in the previous year, were treated for coccidiosis during the period under review. In the Bombay Province a single case of bovine coccidiosis was detected, while in the Central Provinces and Berar there were 39 cases which on treatment with coccidiosis powder yielded varying results. In the Central Provinces and Berar infection with *Eimeria smithii* was detected in 40 cases (cattle and buffaloes). In Mysore State an enzootic outbreak of enteritis due to coccidial infection occurred among cattle of Thirthahalli and Koppa. It is also reported that this disease ran a chronic course in the adult animals and an acute course in young calves at the Irwin Canal Farm. In Assam 27 animals of all ages were reported to have died of coccidiosis within six weeks. Adult cattle are believed to be carriers of the disease and it is stated that the oocysts assumed pathogenic role due to some undetermined pasture and weather conditions. The results of inquiries made at the breeding farms and in the hilly districts of the Punjab showed that in these localities primary coccidiosis did not occur amongst calves but that it frequently occurred after an attack of rinderpest.

Coccidiosis in poultry. The coccidium, *Eimeria tenella* has often been met with in fowls kept at the Imperial Veterinary Research Institute, Mukteswar, for experimental purpose, but in no instance has mortality in these birds been definitely ascribed to infection with this parasite. Arrangements are now being made to pursue this question in conjunction with the Poultry Research Section of this Institute at Izatnagar. In four fowls in Mysore an infection

with *E. necatrix* was encountered. In Bengal it is stated that coccidiosis is a common disease of poultry. In Orissa an outbreak of virulent form of coccidiosis occurred among chicks of two to ten weeks old belonging to the Agricultural Farm, Angul, during March 1939. Cases of coccidiosis in fowls were also reported during the year from the Central Provinces and Berar.

Coccidiosis in dogs and sheep. During the year under report six cases of cannine and one of ovine coccidiosis were recorded from the Bombay Province.

Spirochaetosis in fowls. In the Central Provinces and Berar cases of fowl spirochaetosis were successfully treated with sulfarsenol. In Mysore State an outbreak of spirochaetosis occurred in a flock of Rhode Island Reds which were treated with Atoxyl. During the year an outbreak of spirochaetosis also occurred in the North-West Frontier Province.

Black-head in turkey. In Mysore State a bronze turkey mainfested symptoms of black-head and on *post mortem* examination it is reported to have showed the causal agent of the disease, namely, *Histomonas meleagridis*, in the sections of liver.

Sarcosporidiosis in buffalo. Cases of sarcosporidiosis in buffalo were reported from Assam. One animal died after showing symptoms of incoordinate action of the hind quarters and marked stiffness in locomotion.

Rhinosporidiosis in cattle and horse. Several cases of rhinosporidiosis in cattle and two horses were recorded in the Central Provinces and Berar. It is claimed that these cases were successfully treated with Antimosan.

Encephalitozoon cuniculi infection in a rabbit. This parasite, hitherto unrecorded from India, was observed to occur in the kidney of a rabbit which had succumbed to experimental infection with trypanosomiasis at the Imperial Veterinary Research Institute, Mukteswar. This organism is known to prodnce spontaneous eucephalitis and nephritis in these animals. An article containing a detailed morphological account of this organism has been sent for publication in the *Ind. Jour. Vet. Sci. & Anim. Husb.*

(c) *Helminthology*

At the Imperial Veterinary Research Institute, Mukteswar, the following items of research were completed :—

i. A new fluke, *Cymbiforma indica* Bhalerao, of the family Notocotylidae, occurring in goats, sheep and cattle in Mukteswar was discovered. The severity of infection with this parasite, particularly amongst goats is very great. The anatomy of the worm, inclusive of the excretory system, has been studied in detail.

ii. Observations were made on the tolerence by goats of the degree of infection with *Hæmonchus contortus* and as a result of this it was noted that about one hundred worms can be harboured by these animals without showing any outward symptoms of verminous affection.

iii. A very important discovery from the phylogenetic point of view of Trematoda was made during the period under review. This was the discovery in *Atrophecæcum burminis* (Bhalerao, 1926) of an atrophied intestinal cæcum on the right side, while the same structure on the left side is quite normal.

iv. Observations on the nodular disease of sheep and on the infection of the pasture with larvæ of *Oesophagostomum columbianum* were made on the

Sheep Breeding Farm at Bhamburda, near Poona, and measures to control the disease which proved very successful were suggested.

v. A popular brochure on liver-fluke disease was prepared.

vi. The following new records were made during the year :—

1. *Parafilaria bovicola* from the subcutaneous nodules of cattle in Karachi.
2. *Coenurus* of *Multiceps gaigeri* from the mucous membrane of the eye of a sheep in Broach.
3. *Gastrothylax crumenifer* from the oesophagus of a bull in Cuttack.
4. *Mesocestoides litteratus* from the intestine of a cat in Mukteswar.
5. *Dictyocaulus filaria* from the bronchi of buffaloes in Peshawar.

In the United Provinces Helminthological Research Scheme financed by the Imperial Council of Agricultural Research, work was carried out under the following heads :—

1. *Systematic survey of helminth parasites*

For this work daily collection of helminth parasites from the carcases of cattle, buffaloes, sheep and goats was carried out at the slaughter houses at Lucknow and material from other places was obtained through the courtesy of the Directors of Veterinary Services, United Provinces, Bengal, Assam, Bihar and Orissa. The following additional parasites were recovered during the year :—

I. *Trematoda* :

(i) *Fischœderius cobboldi.* (Buffalo, cattle and sheep).
(ii) *Gastrodiscus secondus.* (Elephant).

II. *Nematoda* :

(i) *Strongyloides papillosus.* (Goat and sheep).
(ii) *Ascaris lumbricoides.* (Buffalo).
(iii) *Ascaris vitulorum.* (Cattle).
(iv) *Ascaridia galli.* (Fowl).
(v) *Taxascaris leoniua.* (Lion cub).
(vi) *Murshidia murshida.* (Elephant).
(vii) *Trichostrongylus colubriformis.* (Sheep).
(viii) *Setaria equina.* (Horse).

III. *Cestoda* :

Tænia pisiformis. (Cat).

2. *Incidence of helminthic infestation.*

Work on the incidence of helminthic infestation in cattle, buffaloes, sheep and goats was carried out and results recorded. Seasonal variations during the months of December to March were also recorded. The most common examples of fresh types of multiple infections met with were :—

(i) ***Bunostomum trigonocephalum*** **and** ***Gaigeria pachyscelis*** **in the intestines of goat and sheep.**

(ii) ***Œsophagostomum columbianum*** **and** ***Trichocephalus ovis*** **in the cæcum of goat and sheep.**

3. *Life-history*

The work under this head was divided into two parts—

(i) Preparation of cultures from eggs of *Paramphistomum cervi, Paramphistomum orthocoelium* and *Cotylophoron cotylophorum* and study of miracidia reared from them.

(ii) Examination of snails for the recovery of Cercarial forms. 1,705 snails from the Kukrail stream and 750 snails from other places round about Lucknow were examined to determine the incidence of infection and to study cercarial, intermolluscar and metacercarial stages.

4. Problems of helminthic infestations reported by the Provinces for elucidation were attended to.

Nasal Schistosomiasis. Several cases of this condition were discovered in cattle in the Madras, Orissa, Bombay and the Central Provinces. It was found in the Province of Madras that antimony tartrate gives better results than antimosan.

Ancylostomiasis of dogs. This condition was encountered in the Mysore State, in the Punjab and in the Province of Bombay. In Mysore it was found that tetrachlorethylene is a very efficient anthelmintic in the treatment of hookworms of dogs.

Acute Paramphistomiasis amongst sheep and goats was investigated at Mowai in Bareilly district. It was found that some owners lost their entire herd on acconnt of this affection. The symptoms were diarrhœa, emaciation and œdematous swellings in the region of the throat. Treatment did not prove successful.

Hump sore in cattle. This condition was studied in various districts in Bengal. As a result of this, it was ascertained that the incidence of this disease is highest in the southern districts. It was observed that the presence of the microfilaria in the circulatory system has apparently very little bearing on the development and the ahatement of the sore.

Verminous pneumonia in goats. This disease caused by *Varestrongylus pneumonicus* is prevalent in the hilly districts of Bengal and causes heavy mortality in goats.

(d) *Entomology*

Transmission of diseases by arthropods. Experiments to determine the species of arthropods, if any, concerned in the transmission of the more important diseases of livestock in India constituted, as usual, an integral part of the activities of the Entomological Section at Mukteswar. During the year, a series of experiments was carried out to test the possibility of theileriasis (*Theileria annulata* infection) being transmitted by *Hyalomma ægyptium* and of canine tick-fever (*Babesia gibsoni* infection) by *Hæmaphysalis bispinosa.* The results in both cases were negative. Progress in work of this kind is necessarily slow, for there is little to guide one in formulating a working hypothesis as to the species of vector, if any, involved in the spread of a disease under natural conditions, so that it may be necessary to experiment with a considerable number of species before positive results are obtained.

During the year, a consignment of living specimens of *Rhipicephalus hæmaphysaloides* ticks was received at Mukteswar, with the report that this species had been responsible for 15 deaths, within the space of two months, amongst goats in a village in the Ahmednagar district, in the Province of Bombay. The infectivity of some of these ticks was tested on a healthy goat, with negative results. It is probable that mortality in cases of this kind is frequently due to anæmia caused as a result of extraction of blood by the ticks. This probability is suggested by the fact that 40 out of a flock of 60 goats are reported to have died, during August and September of the year under report, as a result of heavy infestation with *Hyalomma ægyptium* ticks, in the Karanja Circle of Berar Division, in the Central Provinces, and similar mortality is also reported to have occurred in other parts of the province. In all these cases, the symptoms were those of anæmia followed by progressive emaciation, without any evidence of protozoan or other forms of infection. Infestation with ticks is also reported to have been responsible during the year for lowered efficiency amongst cattle in certain districts in Assam.

Bionomics and life-history of arthropods. In the Entomological Section at Mukteswar, observations were made upon the bionomics of the cattle tick, *Boophilus australis*, for very little exact information was available concerning the habits of this well-known species of cattle tick under Indian conditions. It was observed that the larval and nymphal stages of this tick were completed in about 9 and 15 days respectively. Pairing of the adults took place shortly afterwards and the females fed for about 10 days after fertilization. The average number of eggs laid by a female was over 2,000.

Parasites of ticks. During July of the year under report, numerous examples of a hymenopterous parasite were bred from a consignment of *Hæmaphysalis bispinosa* ticks, received from Sirsi, North Kanara. These proved on examination to be *Hunterellus hookeri*, the occurrence of which had been previously recorded only once (in 1921) in India. The parasite has been studied extensively in the United States of America, in relation to the question of its utilization in the biological control of ticks. A proposal for undertaking similar studies on this parasite in India has recently been submitted for the consideration of the Imperial Council of Agricultural Research.

Warbles. As the result of a series of intensive studies, carried out in the Entomological Section at Mukteswar, on the moisture requirements of *Hypoderma lineatum*, it is now possible to rear out winged specimens of this species without difficulty. It has been observed that, in order to ensure the successful emergence of the flies from their puparia, it is necessary to maintain the latter at a temperature of 22°C. and a 5 per cent soil moisture.

Periodical observations carried out on the bionomics of the warble-fly of the goat showed that the entire larval development of this species, extending over a period of 7-8 months, was accomplished on the back of the host, without the occurrence of a stage of migration. On this point, the life-history of *H. crossii* therefore differs from that of *H. lineatum*.

The results of a warble-fly survey carried out in the Kashmir Valley during September and October of the year under report showed that, while goats in that locality were infested with *H. crossii* to the extent of nearly 80 per cent, cattle were almost free from infestation. The infestation was equally heavy amongst goats in the Kulu Valley, as also in the hill districts of Waziristan

and Hazara in the North-West Frontier Province. It is noteworthy that while *H. lineatum* was otherwise widespread in this latter province, the district of Bannu, which is damp and marshy, was practically free from it, thus pointing to the possibility that an excess of soil moisture is inimical to the development of the fly in its pupal stage. It is of interest that two cases of warble-fly infestation occurred in buffaloes in Peshawar.

During the year, the occurrence of warble-fly infestation was reported from the following taluks in Sind :—Sanghar-Nara Valley, 30 to 40 per cent ; Tatta, 20 to 30 per cent ; Mirpur-Sakro, 30 to 40 per cent ; and Hala, 40 to 50 per cent. Evidence is as yet not available of the occurrence of warble-fly infestation in Ajmer-Merwara.

In Madras, only one case of warble-fly infestation was reported during the year and this was from the district of Kistna. In Bengal, the pest was of infrequent occurrence in so far as the plains districts were concerned, but the incidence of infestation was high in the hill districts. In these latter areas, the use of derris and other dressings has been advised for combating the pest.

During the year, six cases of warble-fly infestation were treated experimentally in Orissa, while 27,046 warble dressings were carried out at the Hissar Cattle Farm, as against 24,094 during the previous year.

Damage to hides caused by ticks. A fact of considerable importance that came to light during the year is the occurrence of damage caused to hides by tick bites. The damage, which is particularly serious in Madras and Bengal, manifests itself in the form of abrasions on the grain of the hide, which in consequence becomes spotted and disfigured. It has been estimated that on this account hides in certain localities are depreciated to the extent of nearly 50 per cent. In the Entomological Section at Mukteswar, the reproduction of such damage to hides was effected experimentally by subjecting a bull to the bites of ticks. A scheme of research into the subject of tick damage to hides in India has been submitted for the consideration of the Imperial Council of Agricultural Research.

Mange. During the year, outbreaks of mange or scab in sheep and goats, with heavy mortality in some instances, were reported from the provinces of Madras, United Provinces, Assam, Sind, North-West Frontier Province and Baluchistan.

A form of skin disease, believed to be due to *Sarcoptes scabiei* var. *capræ*, is reported to affect goats at Balakot (base of Kaghan Valley) in the North-West Frontier Province. The condition, in its advanced stages, is characterized by a stiffening and paralysis of the limbs, this being eventually followed by death.

Several cases of follicular mange amongst cattle and dogs were also reported during the year.

Ectoparasites of poultry. An outbreak of fowl spirochætosis in a flock of Rhodes Island Reds was reported during the year from Mysore. The transmitting agent involved in this outbreak could not be ascertained, but examples of the mite, *Dermanyssus gallinæ*, were collected from some of the affected birds. Considerable economic loss is also reported to have occurred in this State as a result of heavy infestation of poultry with the following species of parasites : *Menopon stramineum*, *M. gallinæ*, *Lipeurus heterographus*, *L. variabilis* [*L. caponis*], *Dermanyssus gallinæ*, *Cnemidocoptes mutans*, *Cn. gallinæ*

and *Cytoleichus nudus*. Some of the infested birds showed chronic purulent inflammation of the air-sacs and from two such cases dead air-sac mites (*C. nudus*) were recovered.

At Kulu, in the Punjab, a flock of fowls suffered from a heavy infestation with Gamasid mites during August of the year under report. These mites are alleged also to attack human beings in that locality.

Anatomical studies. The mouth-parts, including the so-called buccal complex, of ticks formed a major subject of study in the Entomological Section at Mukteswar. The presence of what is believed to be the hypopharynx of insects has now been demonstrated in several representative species of ticks. A critical study of the anatomy of the tick, *Ornithodorus papillipes*, was also made during the year, with special reference to Gene's organ and blood hæmocytes. A detailed morphological study of the young larvæ of *Hypoderma crossii* showed that the structure of their mouth-hooks differed, in certain essential features, from those of the larvæ of *H. lineatum*, thus providing a ready means of differentiating the two species.

Cattle and sheep dips. The increasing popularity of dipping tanks as a means of combating cattle ticks in India is illustrated by the fact that, in the Province of Bombay, two such tanks were added to the previously existing ones, during the year under report, one of these (at the Gowshala, Kandivli) having been opened, in January 1939, by His Excellency the Viceroy and the other (at Gilligan Cattle Breeding Farm, Pimpale), in September 1938, by the Collector, East Khandesh. Towards the close of the year, a dipping tank was under construction in the Bijapur district, whilst plans were under way for the construction of three others. The actual dipping operations in the Province of Bombay were started in January 1939, and since then 400-600 animals have been dipped every fortnight, with a maximum of 445 animals dipped in one day. In localities where these operations have been carried out under the direct supervision of the Veterinary Department, the results are reported to have been greatly appreciated by the cultivators and also by persons interested in animal husbandry.

In the Punjab, proposals have been made for the construction of three cemented sheep dips in the Ferozepur District and also for the provision of five portable baths at other important sheep centres at a total cost of Rs. 55,000.

Record of new species. The occurrence of *Rhinoestrus purpureus* Brauer, the well-known bot parasitic, in its larval stages, in the nasal sinuses of the horse, was recorded for the first time in India, during the year under review. Specimens of this species were collected from the head sinuses of a donkey that had been destroyed for demonstration purposes at the Punjab Veterinary College.

(e) *Deficiency diseases and toxicology*

DEFICIENCY DISEASES

Abortion and sterility. Bovine abortion is assuming increased importance, especially in dairy herds, on account of its being responsible for a considerable amount of financial loss to dairy proprietors. In one herd in the Bombay Presidency, it had assumed an acute form. Analyses of various feeds

indicated a possible deficiency of minerals. Experiments conducted at the Palghar dairy (Bombay Province) indicated that a suitable supplement like 'Churn Brand' mineral feeding flour resulted in the normal calving of 18 out of 22 buffaloes.

In Bengal also an investigation into bovine abortion indicated that in addition to the *Brucella abortus* Bang infection, nutritional deficiencies might be responsible for a considerable percentage of the cases.

Similar cases of abortions and retention of placenta in cattle, goat and sheep have been reported from Central Provinces.

A small group of Hallikar cows of a private dairy farm in Bangalore were reported to be returning to the bull in spite of repeated services. Mineral deficiency was suspected, and on supplementing the ration with 'Churn Brand' mineral flour as well as bone meal, the trouble ceased. The animals started putting on weight and conceived successfully.

In order to study the effects of nutritional deficiency in causing abortions and sterility in cows a comprehensive investigation has been initiated at the Imperial Veterinary Research Institute, Izatnagar on young heifer calves of Sahiwal breed, which is reputed to be one of the heaviest milkers in India, and it is amongst the heavy milkers that the greatest incidence of abortion and sterility is reported.

Cases of abortion and sterility in mares due probably to dietary deficiency have been reported from Kunigal and Hessarghatta in Mysore State.

Investigations on this condition are in progress in the Punjab and Madras provinces also.

Bone diseases. Bone diseases of nutritional origin appear to be of common occurrence in certain parts of India. They may be divided under the following sub-heads :—

(*a*) *Rickets*. Numerous cases of rickets among growing chicks were encountered in the Mysore State, and the manifestation of the condition was assigned to the failure of the bird to obtain sufficient lime salts from the feed.

Rickets in pups appears to be fairly common and this condition is especially met with in early spring. Investigations at the Imperial Veterinary Research Institute, Mukteswar on material obtained from 8 pups indicated that both the serum calcium and phosphorus were poor or that there was a gross imbalance in the calcium and phosphorus ratio. Bone analyses showed that the reserve of both the lime and phosphoric acid in the bones was very poor. In the case of two pups the vitamin A liver reserve was almost nil, but in the livers of the other two the vitamin A content appeared to be within the normal range of variation.

(*b*) *Osteomalacia*. Osteomalacia or osteomalacia-like disease has been observed in Anantapur district in the Madras Province, in Jatprol and Wanparti Samsthans in Hyderabad-Deccan and in Bihar. The chemical analysis of the roughages and concentrates carried out at the Imperial Veterinary Research Institute, Mukteswar indicated that either there is a gross deficiency of lime or phosphoric acid in the ration or it was imbalanced. Portions of the ribs and long bones of the affected animals showed low inorganic ash and phosphoric acid. The soil and water were also examined and the soil was found remarkably poor in nitrogen and phosphorus. Serum analysis in some cases showed low phosphorus. The soil and water from the affected areas in Madras

and Hyderabad were examined for their fluorine content, and it appears that fluorosis may be partially responsible for this condition of the bones.

Enzootic cases among buffaloes have been reported from Assam of a disease characterised by incoordination of the hind quarters and inability to work as a plough animal. The condition is generally associated with lameness of both the hind legs, and in certain cases inability to rise. When the affected animal at the last stage of the disease falls down due to loss of control of the hind quarters it usually remains in the recumbent position till death. Further investigations are in progress.

Avitaminosis-A in farm animals. The occurrence of avitaminosis-A in farm animals has been reported from different parts of the country. It appears that one of the chief reasons of this deficiency is the lack of carotene in roughages fed to the animals. A considerable percentage of the samples of hay received at Mukteswar for analysis from the affected areas were found to be very poor in carotene. Investigations undertaken at Mukteswar indicated that most of the carotene is destroyed by the ordinary methods of sun curing and that variations in the carotene content of hay and fodder plants are not only due to the difference in the species of the plant from which hay is produced but also to the stage of maturity of the plant at the time of harvesting. It has also been observed that a considerable part of the leafy portion of the fodder plants, which contains about 70 per cent of the total carotene contained in the plant, is lost by the ordinary processes of drying and transporting.

In Orissa the Conservancy cattle of Puri Municipality which are kept on paddy straw, crushed kulthi and rice bran of inferior quality with practically no green fodder showed typical symptoms of avitaminosis-A. There were cases of bad eye affections and of epileptic fits among them in addition to their predisposition to a high incidence of tuberculosis and other diseases.

Night blindness was discovered in 4 bullocks at Khamgaon in Berar due to the animals being kept on dry fodder from January to the end of June. On the administration of green leaves the animals recovered normal sight.

Incidence of avitaminosis-A in poultry was specially observed during the hot and dry summer months in Mysore when there was a considerable dearth of green feed. The condition was characterised by staggering gait, discharge from the eyes and nostrils and inflammation of the eyes. The trouble was controlled by the provision of cod-liver oil to the extent of 1 per cent in the mash.

In Assam 'roup' like symptoms were seen mostly amongst young chickens and the adults were rarely affected. The area round the eyelids was swollen and was soft and cold to touch due to the accumulation of clear straw coloured fluid. On the cornea calcareous grain like deposits insensitive to light were seen in some of the cases.

Avitaminosis-A seems to have been responsible for several cases of abortion and retention of placenta both in cattle, goat and sheep in Central Provinces.

It is widely believed that vitamin A exercises ar effective control in maintaining the physiological defences of the mucous membrane, though no recorded evidence is available to explain this phenomenon. Since proteins play an important role in all immunological reactions, an interesting investigation was undertaken at the Imperial Veterinary Research Institute, Mukteswar, to examine critically the various fractions of serum proteins of normal and

vitamin A deficient cattle and to determine which fraction is most affected under these conditions. It was found that the total protein, euglobulin and total globulin fractions of serum of vitamin A deficient animals are considerably decreased as compared with the normal. Since the globulins are associated with the antibody forming capacity of the organism, it may be that the significant decrease in the amount of euglobulin and pseudoglobulin I in the case of vitamin A deficient animals is also responsible for rendering them more susceptible to infection.

Nutritional aspects of equine encephalomyelitis. Enzootic cases of encephalomyelitis in equines occurred in Bihar, Punjab and the North-West Frontier Province. The analyses of fodder and concentrates received from some of the affected areas at Mukteswar indicated that either there was a gross imbalance of calcium and phosphorus or a deficiency of phosphorus. Serum analysis of the affected animals showed that whereas the amount of calcium was normal, the inorganic phosphorus content was significantly poor. Another observation made on some of the cases was that tbe roughages fed to these animals prior to the onset of the disease were either entirely devoid of or very poor in carotene and the livers of the dead or killed animals were negative or at a very low level of vitamin A reserve.

Unproductive animals and calcium deficiency. (*a*) The majority of the animals in Orissa subsist on grass. The analysis of these grasses in the Ganjam district showed that whereas the phosphorus content was normal the amount of calcium was rather low, and it is concluded that calcium deficiency may be one of the factors resulting in the survival of a type of animal which is small, undeveloped and economically unproductive for work and milk yield.

(*b*) *Soft shelled eggs and mineral deficiency.* This disorder was recognised in hens in Mysore laying consistently soft shelled eggs and was remedied by the provision of adequate supplies of bone meal and lime grit in their ration.

Perosis. The incidence of a peculiar condition of 'deforming leg weakness' arising as a result of slipping of the achilles tendon from its condyloid groove was encountered in Mysore. The disease was observed among newly hatched Rhode Island Red chicks of the Hebbal Farm between the ages of four to six weeks, and was characterised by a sudden and almost overnight appearance of the symptoms. The cause of this condition is suspected to be a deficiency of manganese.

Avian gout. Seventeen cases of visceral and articular gout were discovered in the Hebbal Poultry Farm, Mysore. The probable cause was a high protein diet and lack of exercise, and a preliminary experiment on a batch of cockrels has confirmed this view.

The findings are of interest, as the disease is generally said to be confined to birds of advanced age, whereas most of the cases met with in this farm were amongst chicks between the age of four to ten weeks.

Depraved appetite. Depraved appetite which is caused by imbalanced or insufficient food supply is a common condition in animals. Tendency to lick the soil and eat fragments of bones was encountered among a herd of Hallikar cows in Bangalore. Feather pecking and cannibalism have been met with causing considerable damage to poultry in Mysore. When, however, sufficient amount of food with adequate quantities of minerals was supplied the trouble disappeared.

Gizzard erosion. In Mysore a large number of birds showed on postmortem examination an erosion and extensive exfoliation of the lining membrane of the gizzard. The clinical symptoms consisted of loss of condition, poor growth, ruffled feathers and depression. Both the clinical symptoms and the postmortem lesions correspond with those associated with the 'Nutritional gizzard lesion' in chicks caused by a feed either poor or lacking in the so called 'Anti-gizzard lesion' factor.

Crazy chick disease. Another disease of undiagnosed nature in Mysore presumably of nutritional origin was encountered among very young chicks of two to four weeks of age. The symptoms were characterised by muscular inco-ordination manifested by complete helplessness, a partial or complete retraction of the head and trembling of the head and limbs. Death occurred within a short time after the symptoms appeared.

Toxicology

A comprehensive investigation has been undertaken at the Imperial Veterinary Research Institute, Mukteswar to determine the effect of feeding the pea *Lathyrus sativa* and its phytotoxin in horses. The effect of nutritional deficiency, particularly of vitamin A, in increasing the susceptibility of an animal to lathyrism is also being investigated.

Lantana camera, Liem, has been responsible for causing death of an imported cow in the Kangra Valley. The cow was seen browsing on the flowers and leaves of the plant a few hours before the onset of symptoms, which were: inappetence, nervous excitement, weakness of the hind quarters, and total blindness of both eyes.

Lantana is assumed to be responsible also for the death of three calves in a valuable herd in Shillong.

An extensive programme of studies on plants toxic to animals was undertaken at the Imperial Veterinary Research Institute, Mukteswar and the toxicity of *Nerium Odorum* and *Datura stramonium* has been carefully studied besides a few others, which have been causing a considerable loss to animals in the North-West Frontier Province and Kumaun Hills.

Nineteen cases of criminal poisoning were reported from North-West Frontier Province and several others from Gaya in Bihar. The chemical examination of intestinal contents indicated the presence of arsenic.

Flourine poisoning due to the presence of fluorine in drinking water was suspected in certain parts of Madras Province and Hyderabad State, but confirmatory evidence in the case of livestock is still wanting.

From a critical examination of the reports of different provinces it appears that many of the plant poisoning cases pass unidentified and are classified under obscure diseases. The number of deaths amongst animals assigned to other causes and obscure diseases in some provinces, e.g. Assam, is very high.

2. Animal nutrition

The Animal Nutrition Section, Imperial Veterinary Research Institute, Izatnagar

This Section rendered useful service to Agricultural and Veterinary Departments of the various provinces and States by supplying technical advice in

response to numerous enquiries relating to nutrition of farm stock and carried out research work on several nutrition problems confronting Indian agriculturists.

A special study of the metabolism of different forms of sulphur in the animal organism was undertaken on bullocks, sheep, rabbits and dogs. The following forms of sulphur were used in this investigation :—(*a*) Elementary sulphur (Flowers of sulphur), (*b*) Inorganic sulphur (sodium sulphate), (*c*) Organic sulphur (protein sulphur). The latter was studied in two parts (1) by increasing only the organic sulphur and keeping the sulphate constant and (2) by increasing both the organic and inorganic sulphur fractions simultaneously. In both these latter experiments, along with increased sulphur intake, larger quantities of sulphur were ingested and its influence noted. The administration of extra sulphur in any form to animals on a low sulphur ration always leads to absorption and metabolism of the same causing all the urinary and sulphur fractions to increase. This metabolism and utilisation is highest when the sulphur is ingested in organic form and less when in the inorganic form as sulphate.

Comparative study of the analytical methods employed for the determination of calcium, phosphorus, chlorine, magnesium, soda and potash in fodders, fæces and other such biological material in the different laboratories in India was undertaken for obtaining information regarding the best technique to be employed to obtain the most accurate results consistent with speed and ease of manipulation. Some interesting and valuable results have since been obtained.

A colony of albino rats of uniform nutritional history is being raised so that a breed capable of withstanding the extreme temperatures of the plains without showing wide individual variations will be available for experimental work. Such a colony is of extreme significance for conducting preliminary experiments to be later on applied or conducted on large animals for investigating problems on vitamins, minerals and proteins, etc.

The Military Dairy Farms

It is stated that lack of condition of cows in hill stations was due to altitude and shortage of green fodder and not due to lack of minerals. There was little difference between undecorticated cottonseed and groundnut cakes, both of high fibre content, for milk production.

Young animals ate the curd of coagulated separated milk readily but did not show the same live-weight gain as when fed on sweet milk due to loss of feeding value of the whey. It has now been decided to feed the curd in the whey. An experiment comparing the feeding value of separated milk against concentrates was in progress.

Imperial Council of Agricultural Research

Scheme for the manufacture of cattle-feed from molasses.—Past work conducted with molassed feed in different centres in India has produced conflicting reports as to the efficacy of this feed as a substitute for certain others. Consequently the Sugar Committee of the Imperial Council of Agricultural Research at its meeting held in March, 1938, decided that feed

containing bagasse screenings and molasses should be prepared and sent to feeding centres to ascertain what common fodders they could economically replace.

The work for the period under report was conducted in order to give effect to this recommendation and to see how far the use of finer screenings of bagasse in the feed could remedy the trouble which has hitherto been found. Consequently feeding experiments with bago-molasses are in progress at five nutrition centres in India, and while the work is not yet complete provisional reports show that the new feed is economical as a part substitute for other animal rations.

The Animal Nutrition Committee and the Advisory Board of the Imperial Council of Agricultural Research have considered these reports and it has been decided that a more exhaustive study is yet required to assess the true food values of these by-products of the sugar industry, and that further work must be carried out in collaboration with the Animal Nutrition Centre at Izatnagar ; also that work should be carried out on the maximum amounts of molasses that can be fed to cattle in addition to or as part substitute for any particular item in the ration. It was also suggested that suitable, cheap and practicable methods be worked out for utilising local raw materials and molasses, and the food values of these tested at Animal Nutrition Centres.

MADRAS. During the year under report work has been conducted on the following lines at Coimbatore under the Animal Nutrition Scheme financed by the Imperial Council of Agricultural Research

(1) Mineral metabolism studies.
(2) Blood studies for mineral deficiency.
(3) Pasture survey.
(4) Use of mineral mixtures for prophylaxis.
(5) Herbage protein studies.
(6) Work on the biological values of cereals.
(7) The effect on the composition of the flesh of poultry by feeding groundnut cake and fishmeal and
(8) Studies on the influence of manuring on pastures.

Mineral metabolism studies

This work was conducted on cross-bred cows and Kangayam heifers and the conclusion arrived at is that a daily assimilation of 35 gram each of calcium oxide and P_2O_5 is adequate for growth and pregnancy. Heavy milking cows require additional amounts of calcium and phosphorus depending on the milk yield. It appears also that cows in heavy milk draw to a considerable extent upon the body reserves of calcium even when large amounts of calcium are fed and that this loss is replenished in subsequent dry periods. It is interesting to note that whereas a heavy milk yield is generally associated with a negative calcium balance, the balance of phosphoric acid is generally positive, and that a change in the composition of the added mineral mixture from equal parts of lime shell and bone meal to 3 parts of lime shell to 2 of bone meal did not suffice to overcome the negative calcium balance in the case of cows yielding 15-20 lb. of milk daily.

Blood studies for mineral deficiency

A very valuable piece of work was carried out on the relationship between mineral deficiencies in pastures and a corresponding diminution in blood minerals and the incidence of disease consequent thereon. There are certain areas in the Madras Province where the pastures show definite deficiency either in calcium and phosphorus, or in both. In these districts the bovine population suffers from a disease locally known as 'Vayu Potlu', the symptoms of which resembles those of arthritis.

A technique has been evolved for obtaining samples of blood on the spot from affected and normal animals, and the analyses show striking differences in blood composition as between normal and affected animals. The affected animals invariably showed a normal, or even high calcium content in the serum, whilst the phosphorus content was distinctly low, while in the normal animals both calcium and phosphorus were approximately normal. Animals suffering from this disease therefore show a picture of profound imbalance of the minerals of the blood, which confirms the already recognised relationship between low blood phosphorus content and deficient phosphorus nutrition. It is also interesting to record that the incidence of this disease appears to be related also to the increasing consumption of groundnuts on a large scale during the past 25 years, and extensive analyses of the composition of groundnuts in this connection have been carried out, which show a generally low content of phosphorus. Another factor bearing on the incidence of low phosphorus level appears to be the high incidence of fluorine in many of the local waters.

Very characteristic symptoms are exhibited by animals which drink water containing a fluorine content ranging from 0·5-2·0 parts per million, whilst the water from villages where the cattle were normal show a considerably lower total solid content and little or no fluorine. There appears to be a considerable parallelism between the etiology of fluorosis and 'Vayu Potlu'.

Investigations have also been carried out on the composition of the rocks and soils for fluorine content and work is still in progress. Fluorosis and its relationship to the fluorine in the rocks, soil and water of various tracts appears to be a major problem involving heavy losses to the people.

Pasture survey

During the year under report the pasture survey of the Madras Province has been extended to the districts of Guntur, Kistna, East and West Godavari and Vizagapatam and the northern part of the Kurnool district, and has been instrumental in indicating areas of mineral shortage in fodders, in pastures and imbalance in animals, and a detailed report will follow when this investigation is finished.

Use of mineral mixtures for prophylaxis

Work has been continued on ascertaining the amount of mineral supplements required to restore calcium imbalance to a positive balance and as addition of shell lime and bone meal was unable to restore this balance properly, efforts will be directed to ascertain whether other lime supplements such as calcium lactate can be effective in restoring the lime requirements of heavily milking cows.

Herbage protein studies

Studies on the effect of soil treatment on crop composition have been undertaken, partly in the laboratory, and partly in the field, with paddy. The evidence is yet incomplete but tentative conclusions so far arrived at indicate that different types of cereals under different manurial treatments are variably affected in regard to their nitrogen distribution. This study requires to be extended to include the herbage. Work has also been done on paddy irrigated with ordinary channel water and no manure, and paddy irrigated with water from an activated sludge plant containing 1·5 parts nitrogen per 100,000, and shows that paddy seedlings in all stages of growth showed a higher nitrogen content when irrigated with sludge water than the controls, but there appear to be no definite differences in the distribution of nitrogen in the fractions analysed.

Corresponding work which is still in progress has been carried out on maize and lucerne.

Biological values of cereals

During the year under report the work conducted last year on the biological value of rice grown under channel and effluent water using rats has been continued, and shows the increased biological value of rice irrigated by effluent water.

Work on fish and poultry has not yet produced any well defined results and is being continued.

Work has been carried out by the Department of Agriculture, Madras, during the past year on the protein requirements of working bullocks, and the results worked out by regression equations and the usual statistical methods indicate that the nitrogen requirement was a linear function of the work done and that the endogenous nitrogen as shown by urinary nitrogen output was also a linear function of the work. As a result of this study, feeding standards have been formulated for working bullocks with paddy and *cholam* straws and a number of concentrates, and these rations will be tried in the various agricultural research stations.

The Madras Veterinary Department has carried out a number of analyses of waters from wells in the Kalyandrug taluk, Anantpur district, which were supposed to contain an excess of flourine responsible for rheumatic troubles amongst working animals in the locality. Excessive amounts of fluorine and total solids were found in all the waters studied.

BENGAL. Work conducted at Dacca during the past year embraces, (1) an investigation on the feeding values of rice straw when fed with rice by-product (*kura*), cake and molasses; (2) the relation of live weight with lime content and lime requirements; (3) the mineral assimilation from Napier silage; (4) investigations on the production, utilization and feeding values of rice by-products; and (5) feeding tests on the comparative values of *aman* and *aus* varieties of rice straw.

(1) Initial work indicated the disinclination of animals to take as much as two lb. of *kura*, the daily ration of which was subsequently reduced to 1 lb., and the original idea of using wet rice straw had to be abandoned as the supply failed. The feeding trials were, therefore, continued with dry *aus* straw with

regulated amounts of cake and molasses, the dry straw being moistened before feeding as it was not relished by the animals.

Full data are given of the weekly averages of live weight, and the general conclusion is drawn that the animals improved in condition subsequent to the feeding of wet *aus* straw. The trials were somewhat handicapped on account of want of a regular supply of the required material and inadequacy of staff. It is proposed to do properly controlled digestibility tests next season which should give much valuable information which is still lacking in regard to the materials used in these trials.

(2) It was reported last year that in the case of adult animals lime content and lime requirements are both functious of the live weight, and work in this direction has been continued in the year under report. Efforts have been made to ascertain whether there were any differences between the Krishnagar method for ascertaining the lime requirements, and a combination of the Krishnagar and Dacca methods. Equations for the respective methods are given and the analyses of variance under each method have been worked out. The conclusions arrived at from the two methods do not show any appreciable differences, and this appears to confirm the results obtained in regard to lime requirements and live weight, with a ration of *aus* rice straw and cake. This finding requires to be tested with other feeds also.

(3) The general results obtained from this investigation were presented last year, but further work has confirmed the suggestion that Napier silage should not form a sole ration.

(4) It was found from the work on rice *kura* that rice products vary greatly in composition due to various methods of milling. It is well-known that parts of the rice grain contain constituents essential for health and when these are removed feeding with the resultant products is followed by disturbances in health or actual disease. A preliminary survey has been undertaken in connection with the composition of the various rice products available in Bengal, but the investigation needs systematic and detailed treatment for which purpose additional staff has been asked for.

(5) Work has been started to ascertain the comparative feeding values of *aman* and *aus* straws with various combinations of concentrates. The work is in progress and will be reported on in due course.

BIHAR. Systematic work has been continued during the past year on factors affecting the composition of fodders from different localities, particularly in regard to soil conditions and the effect of the season. The ten fodders which were studied were :—*Juar*, maize, *meth*, *khesari*, berseem, Napier grass, *Dhoob* grass, paddy straw, barley-*bhusa* and wheat-*bhusa*. It has already been recognised that the soils of Bihar vary considerably in composition and some are definitely deficient in certain essential plant food constituents. This variation might be expected to be reflected in the composition of different fodders, particularly those which are not as a rule regarded as the richest animal fodders. It is interesting to note that berseem gave the best results from all the localities surveyed, and that it invariably showed a high protein content and was rich in most of the essential minerals. The same remarks apply in slightly lesser degree to the other leguminous fodders such as *meth* and *khesari* which were particularly rich in crude protein, calcium and phosphoric acid. As was to be expected, most paddy straws and *juar*

were found to be far poorer than the leguminous fodders, but variations occur in the relative values of these fodders both from year to year and from different districts. The wide spread incidence of varying soil conditions and poor fodders has enabled the investigating staff to delineate Bihar into certain definite tracts showing well defined differences in these respects and the direction of future work will be to study the extent to which the more common, but poor fodders can be enriched by a judicious system of manuring. The effect of such manuring on the composition of fodders will be determined and the resulting effects on animal health. This opens out a wide range of work which should produce much valuable information.

UNITED PROVINCES. Work has been conducted during the past year to study the effect produced on growth and milk production of Hissar cows and heifers, and Murrah buffaloes and heifers, when part of the concentrates normally fed is replaced by different amounts of berseem. It has been found that the growth of Hissar heifers is not affected if 50 per cent of the normally fed concentrates are replaced by berseem, but with any increase beyond 50 per cent growth tends to slacken. With Hissar cows body weight appears to remain constant even when the concentrates are replaced up to 75 per cent by fresh berseem, and studies of the milk yield show that although there is a certain decrease in the milk yield, berseem can advantageously replace up to 75 per cent of the concentrates based on dry weight figures. Murrah heifers appear to slacken in their rate of growth when concentrates are replaced by berseem, and Murrah buffaloes not only loose in body weight but the milk yield falls off very appreciably. This work is proceeding and opens out further investigations both on the utilisation of food ingredients in different fodders by these different breeds and also the relative availability of nutrients from the same feed in regard to cows and buffaloes respectively.

At the ALLAHABAD AGRICULTURAL INSTITUTE, comprehensive feeding trials on young stock, milch cows and working animals with bago-molasses was undertaken in cooperation with the Imperial Institute of Sugar Technology. Definite conclusions have not yet been drawn, but the tentative findings are in conformity with those already expressed in regard to these feeding stuffs. It is suggested that the unpalatability was partly due to the hard fibrous pieces in the bagasse screenings and that finer screenings of bagasse might mitigate this. This problem will be further elucidated in the wider scheme already decided upon.

PUNJAB. The year's work pertained to :—

(a) An investigation into the comparative feeding values of decorticated cotton seed cake manufactured at Cawnpore and locally in the Punjab. The former was found to be slightly higher in starch equivalent and lower in digestible protein.

(b) Digestibility trials on dry cattle of such feeds as *sarson*, *toria* and decorticated groundnut cakes, using oat-hay as the basal ration. Decorticated groundnut cake possesses the highest starch equivalent and the largest digestible protein amongst these cakes. Local decorticated cotton seed cake comes next in digestible protein content, but it is the lowest of all these cakes in starch equivalent.

(c) Investigations on the comparative feeding values of certain grasses at different stages of growth. The main conclusions which can be drawn up to

the present are that the nutritive value of grasses, as indicated by the amount of such essential constituents as protein and phosphorus, shows progressive deterioration as the grasses approach maturity. With a few exceptions this tendency is more marked in the case of grasses from Nurpur, which are very succulent and rich in proteins in their early stages, but which become very poor in protein and phosphate content as they approach maturity. The same tendency, though to a lesser degree, was found in the case of grasses from a dry area such as Sirsa, and whilst the latter, in the later stages of their growth, are sufficiently rich to constitute a maintenance ration for farm animals it seems probable that the former are not.

Digestibility trials proved that *Palwan* grass alone provides a non-maintenance ration and requires up to 1·5 lb. of added *sarson* cake per head per day to provide a maintenance ration for dry heifers weighing up to 800 lb.

(*d*) Feeding trials to determine the value of the Mexican Mesquite tree pods. These trees have been introduced by the Forest Department in the Kangra Valley as a measure against soil erosion. Twice a year they bear a heavy crop of pods containing a pulp which, when ripe, is readily eaten by hill cattle. Digestibility trials have revealed that these pods can be used to make up the protein deficiency in rice straw, the staple cattle food in the Kangra Valley.

(*e*) Research on the feeding values of various food grains, oilseeds and oilseed cakes under the scheme financed by the Imperial Council of Agricultural Research.

3. Animal breeding

(a) *Cattle*

The Imperial Agricultural Research Institute maintained the progress made in previous years in improving the Sahiwal and the Thar-Parkar breeds as good commercial dairy breeds. This sustained effort of improvement was maintained at New Delhi and Karnal respectively, even though the year was not good from an agricultural stand point. Fodder crops were not as good as in previous years. The main feature of the improvement is based on two points: firstly, early maturity, secondly, pre-milking.

Early maturity is undoubtedly one of the most essential characters so desirable in the improvement of the cattle of this country. One of the major defects of our Indian cattle is that they mature late, any improvement in this direction means the saving of vast sums of money to the breeder. From the experiments which are being continued on the Sahiwal herd at this Institute, it is reported that cows successful in earlier experiments continue to maintain their health, condition and high production. Heifers giving less than 4,000 lb. were rare; the average yield of heifers was 18·2 lb. per day (17·8 lb. previous year). A standard has been reached where age, weight and constitution are properly balanced; the heifers are giving high yields with no signs of strain.

Pre-milking must have a good effect on a heifer calving for the first time and should more generally be practised if for no other reason than to accustom heifers to handling. The Institute obtained what must be considered a record price paid for a bull in India when they sold their bull 'Cholomondely' for Rs. 2,700. If breeders in India would only recognize as the U. P. Government have the value of pedigree cattle, breeding could be made a very profitable business.

The Institute was well in the forefront of winners at the All-India Cattle Show, their bull 'Lakhan' being awarded the Championship Cup for the best milk type bull. The Sahiwal herd at New Delhi averaged 21·2 lb. of milk per day, as against 22·2 lb. the year previous, the drop being due to the bad fodder year. The Thar-Parkar herd averaged 19·2 lb. of milk per day, as against 20·2 the year previous.

Improvement of the Hariana herd, maintained at the Imperial Veterinary Research Institute Dairy at Izatnagar, was continued by adopting scientific methods of breeding, feeding and management with encouraging results. The general condition of the herd was good. At the Institute Dairy at Mukteswar, herds of cross-bred cattle, buffaloes and local hill cattle continued to be maintained. For the improvement of the hill type some Afghan bulls and cows were added to the herd.

The Imperial Dairy Institute, Bangalore, continued the breeding policy of developing high milk yielding strains of indigenous breeds of cows, namely *Sindhi and Gir, and Murrah buffaloes. The practice of breeding cross-bred* cows back to Indian bulls at the Wellington Milk Depot was continued. Preparturient milking of heifers and cows at the Institute yielded a daily average increase of 2 lb. and 7 lb. of secretion respectively. Eight out of twelve cows, not standing to the bull, responded successfully when they were given hormonal treatment.

THE PUNJAB. The Punjab is tackling cattle improvement in various ways. Firstly, they have a well-equipped farm at Hissar, which is concentrating on the improvement of the Hissar Hansi breed of cattle and many other livestock activities. The farm issued 562 bulls for breeding work during the year. Government also purchase young bulls of the Hariana breed and rear these for *distribution as future stud bulls at the* Hissar farm. *During the year under* report, this latter activity was not possible owing to the very severe famine in the tract. In the Punjab they have 4 large grantee farms who specialise in breeding the Hissar, and the Sahiwal breeds of cattle and the Nili and the Ravi *breeds of buffaloes. At these grantee farms good pedigree stock are* bred and reared and are a useful source from where to procure bulls of known breeding for further village improvement.

In addition to the above, they have what is known as 'Small Holder Grantees.' In all there are some 223 of such farms, each farmer being required to keep 2 pedigree cows per holding of 25 acres. The Government also have a scheme whereby they subsidise the Rohtak District Board which has to put up a like sum for the feeding of some 800 Hariana cows.

The Dhanni breed is also well catered for by Government. In this scheme six District Boards of the Dhanni breeding tract are subsidised to the extent of Rs. 60,000 annually for the improvement of this breed.

The Punjab also has a very good system of awarding handsome prizes at annual shows which must help considerably in the improvement of the cattle of the province.

At the close of the year there were 6,355 District Board stud bulls in the province as compared with 5,962 in the previous year. The total number of approved buffalo bulls under departmental supervision, including bulls, belonging to the local bodies, was 7,725 as compared with 6,695 in the preceding year.

The work of registration of cattle has commenced and a big castration drive has been initiated.

THE NORTH-WEST FRONTIER PROVINCE. The Province has continued its policy of placing out or making available good stud bulls to the Zamindar breeder. During the previons year some 408 bulls were kept at stud, 54 of these were lost and 77 new bulls added, thus bringing the total to 431 bulls at stud during the year under report. The breeds to which attention is being concentrated are the Dhanni, the Lohani and the Dajal breeds. Sindhi and Sahiwal breeds are being nsed in suitable tracts for the improvement of the milking capacity of the cows. The province has 13 buffalo bulls at stud.

From the number of services recorded, it is seen that a great demand is made for the service of the bulls Government have made available.

BENGAL. Bengal is tackling the cattle improvement problem in two directions. Firstly, by importing bulls in large numbers from the Punjab, and, secondly, by breeding a better type of animal more suited to Bengal conditions. The improvement of the local cattle by the introduction of bulls from the Punjab covers 22 districts wherein some 1,675 bulls have been given free to special bull-caretakers. During the year under review, 167 new bulls were added. The results achieved so far prove conclusively the great benefit Bengal has derived by this mass importation of bulls. The progeny of these bulls are reported to be selling at twice the price of their dams. It is estimated by reports that over 56,000 services were recorded during the year.

At the Dacca Farm some interesting cross breeding is being condncted with the Sindhi and Hariana. The Hariana-Bengal local cow cross has turned out well and seems to be doing better both in milk and draft than the Sindhi-Bengal cross. The pure Hariana has yielded 10 lb. of milk a day ; the Hariana-Bengal cross 8·2 ; the pure Sindhi yields 9·2 ; and the Sindhi-Bengal cross 6·0.

ASSAM. The livestock improvement work in Assam is making remarkably good progress considering the conditions under which it is carried out and the small staff entertained for the purpose. The improvement work consists of improving the local Shillong cattle by the introduction of Freisian and Freisian cross-bred bulls at one farm where a remarkable standard in milk yield has been reached, all cows yielding below 6,000 lb. of milk per lactation being discarded. Sindhi and Hariana bulls are also being used to improve local stock. The nnmber of bulls kept at stud in the year under report shows an increase of over 50 per cent of the previous year. The cross-bred Hariana-local cattle seem to be better equipped physically to resist disease. The work is divided into two sections, one run by Government entirely and the second hy a cattle improvement association, the Livestock Officer being virtually responsible for both the sections.

The province has 4 farms at which improvement work is in progress. They also have forest cattle reserve areas whereat the cattle are improved under direct supervision of the Livestock Department.

It is noticed that jails also are made use of as Cattle Improvement Centres by locating dairies at the jails.

Registration work has been taken in hand.

ORISSA. The cattle improvement of the province is undertaken under 2 schemes—one solely controlled by Government and the other by what is known

as the 'Utkal Gomangal Samiti,' which is run under the advice of the Civil Veterinary Department.

Both these schemes are carrying their cattle improvement work through the purchase and placing out of small Hariana stud bulls, some located in Veterinary Hospitals and others with private individuals.

The Agricultural Farm at Cuttack is being used as a breeding farm. The Jail Department are also helping with a small dairy attached to the Cuttack Jail.

THE UNITED PROVINCES. One of the main features of the livestock development of the Province was the handing over of five districts namely Muzaffarnagar, Meerut, Bulandshahar, Aligarh and Partabgarh from the Agricultural to the Veterinary Department. The United Provinces depend a good deal on the importation and distribution of bulls. During the year under report, some 1,112 bulls of the Hissar, Thar-Parkar and Sahiwal breeds were purchased. The above total also includes Murrah buffaloes. In addition to the above, some 1,043 bulls were distributed from farms. There are 4 Cattle Breeding Farms devoted to the breeding of the following breeds: Hissar, Sahiwal, Thar-Parkar, Kenkatha, Kherigarh and Pouwar breeds of cows and the Murrah buffalo.

Regarding cattle breeding work carried out by the Veterinary Department in the five districts mentioned above, 166 bulls and three buffalo bulls were added during the year to those already maintained in these districts, thus bringing the total to 542 bulls and 30 buffalo bulls. In order to eliminate undesirable bulls from this area 9,201 castrations were performed. Two Cattle Breeding Societies were organized in the district of Partabgarh.

The province has included yet another method of expanding their better cattle production and that is by locating cattle farms with jails. Other provinces might note this very useful method of breeding more good stock.

The province is also looking into the possibility of getting *Gowshalas* to co-operate in cattle improvement. Cattle registration has been started in Muttra District. A beginning has been made in the province by starting a mixed farm, a move in the right direction. At the Allahabad Agricultural Institute work on the breeding and selection of pure bred Sindhi cows, Murrah buffaloes and cross-bred Sindhi-Jersey cows was continued. The results in the Sindhi-Jersey back crosses to Sindhi appear to be very satisfactory. It is evident that the good quality udder of the Jersey has been well established in the grand daughters in the Sindhi back cross. The udder of the Sindhi is notoriously bad and this improvement is a step in the right direction.

THE CENTRAL PROVINCES. The Central Provinces have added another large Cattle Breeding Farm in Dewal Forest area for the breeding of the Malwi breed and the Murrah buffalo, thus bringing their total to 5 cattle farms. The breeds maintained on these farms are: the Malwi, Sahiwal and Gaolao breeds of cows and the Murrah and Nagpuri breeds of buffaloes.

The milk yield of the Sahiwal herd at Telenkheri Farm has increased very appreciably from 2,580 lb. per lactation in the year previous to 2,812 lb. in the year under report.

The province is also making experiments on improving the local cattle by crossing these with pure Malwi bulls.

The province purchased some 78 bulls and these have been located in 68 *controlled breeding centres.*

The province finds it difficult to get out premium bulls for want of interest by the breeders.

BOMBAY. The Bombay Province has maintained its policy initiated in 1919 for the improvement of livestock. The province is dealing with the Gir, the Kankrej, the Khillar, the Krishna-valley, the Hallikar, the Dangi and the Nimar breeds of cattle. At the College of Agriculture, Poona, the Sindhi cattle and the Surti buffalo are receiving attention. The improvement of cattle by the placing of stud bulls in selected areas continues. The registration in Herd Books of known pedigree village stock continues. The Castration Act is gradually being applied to a wider range of villages. The improvement of the milking qualities of the Kankrej at the Chharodi Farm continues. The Gir as a milker is receiving attention at two *Gowshalas.* During the year, two new *Gowshalas* started cooperating with Government—one to breed the Gir and the other to breed the Kankrej. Thus we have three Government Breeding Farms, three *Gowshalas* under Government supervision and two large Taluka Development Association Farms breeding the Nimar. Pedigree bulls for the other breeds are obtained from villages under close supervision of the Livestock Department where pedigrees of all the cattle are maintained.

The Ceylon Government purchased some Khillar cattle from the province and these are much appreciated in Ceylon, a repeated order being received at the close of the year under report.

MADRAS. The most important feature in the development of livestock industry in the Province during the year consists of the transfer of all livestock work from the Agricultural to the Veterinary Department. The setting up of a livestock committee consisting of officials and non-officials, it is hoped, will prove useful in getting at the people and creating greater interest in the subject and finally it has been decided to concentrate all breeding activities to three areas most suitable to the following breeds : Ongole, Kangayam and Hallikar. The pedigree bulls bred on Government farms will be used in the above concentrated areas and efforts will be devoted to the larger production of a good stud bull, which will spread faster into adjoining areas.

The Sindhi herd maintained at Hosur is making great progress. The average yield of the Sindhi herd now reaches 5,500 lb. per lactation with an increase of from 11·9 to 12·5 lb. per day of the farmbred stock over the original importations.

It is also very gratifying to see that the Hosur farm has been able to convert the Kangayam, a purely draught breed, into a very fair milker. Cows of this herd are averaging about 3,500 lb. a year with a daily average over all of about 6·3 lb. The Ongole is also being attended to as a milker and an average of 3,000 lb. per lactation has already been reached.

The Madras Department is also dealing with the Murrah buffalo and very good yields are now being obtained.

Shows are also an interesting feature in the development of better stock in the province.

BARODA. The Baroda State Department of Agriculture is paying attention to the improvement of the Kankrej and the Gir breeds. Some nine Kankrej bulls were at stud during the year as against three the year previous. Six Gir

bulls from high milking strains were placed out as stud bulls. The Palace herd continues to do good work in improving the Kankrej. The State has taken up a new source of development in cattle improvement. They have selected a private farmer who is to work under the direction of State advice, the State giving the farmer a subsidy to run the farm. The State provided the farm with selected stock to make a start.

MYSORE. The Mysore State Government are interested in improving the Amrit Mahal and the Hallikar cattle of the State. In the past it has been the practice of breeding cattle on the open ranch system. A new feature during the year was the break away from this system and the starting of properly, regulated cattle farms. One such farm at Hunsur was started during the year under report. The Department has eight controlled herds of cattle and nine aided herds of the Amrit Mahal breed.

No comparative figures are given as to the increase or decrease in stud bulls maintained by the State.

TRAVANCORE. The Travancore Government have transferred all animal husbandry operations from the Agricultural to the Veterinary Department during the year.

At Trivandrum some three Sindhi bulls were at stud as against five the year before. A stud bull was located at the Kottayam Veterinary Hospital. Some 30 grants of Rs. 50 each were awarded during the year for the maintenance of stud bulls. Stud bulls are located with three Co-operative Societies, two Y. M. C. As. and 25 private individuals. The buffalo breeding station at Koovapady established last year is progressing fairly well.

COORG. The advice given by Col. Sir Arthur Oliver regarding cattle improvement is being carried out. Bulls suited to the various tracts are located in Veterinary Dispensaries and with the Co-operative Societies and private gentlemen. In this way some 23 Zebu bulls and six buffalo-bulls are at stud.

AJMER-MERWARA. This agency has some eight bulls at stud and local bodies have seven bulls at stud.

(b) *Horses and camels*

Owing to the mechanization of transport and the army in India, the demand for horses and camels is gradually decreasing, and as a result people are not taking as much interest in horse and camel breeding. Some work in this direction is, however, still proceeding in certain provinces to meet the local demands. In 18 non-selected districts of the Punjab, there were, during the year under report, 86 horse and 91 donkey stallions. They covered 5,007 and 6,023 mares respectively. Horse and mule breeding societies were at work in some of the districts. Efforts were also made to form a society round each stallion at stud. Similarly, in the non-selected districts of the North-West Frontier Province there were 7 horse and 15 donkey stallions. They covered 314 and 969 mares, respectively. The demand for these stallions in the hill tracts, where the only means of transport are pack animals, is still keen. The number of horse stallions at stud in the Sind province was 5. Of these 4 were in the Upper Sind Frontier and 1 in Dadu district. They covered 204 mares.

In the United Provinces, 56 horse stallions and 10 jacks covered 1,704 and 301 mares respectively. The number of stallions stands remained unchanged.

One of the existing stands, however, closed down and a new one was opened. The Baroda State maintained during the year two donkey stallions. They covered 32 donkey mares. At the Upper Shillong Farm, Assam, there were at the end of the year 11 ponies of which 4 were mares. In the Madras province, the District Board, Coimbatore, continued to maintain two pony stallions. Two more were added during the year. They all covered 71 mares only which shows that full use is not being made of these stallions.

The Council has now taken up the question of the improvement of the indigenous breeds of horses. A note on the subject was discussed at the Animal Husbandry Wing meeting and it was agreed that efforts should be concentrated on the improvement of the indigenous breeds rather than on cross-breeding or the introduction of foreign breeds. As a first step towards this goal, it is necessary that breed characteristics should be defined as was done in the case of cattle. It was suggested that the provinces and states should prepare a note regarding their own indigenous breeds and send it to the Council in order to enable them to see whether something concrete could not be done for the improvement of horses along the lines indicated. At the instance of the Council, a circular letter was, accordingly, addressed by the Government of India in the Education, Health and Lands Department to all provincial Governments and states. In response to this only two schemes for the improvement of Bhutia and Manipuri ponies were received from the Governments of Bengal and Assam respectively. These have since been referred back to the provinces for certain modifications.

An attempt is also being made to get information about the various breeds of asses in India.

So far as camel breeding is concerned, the only province which is doing any work is the Punjab. The District Board, Ferozepore, continued to subsidize 13 selected camel stallions in the dry and arid tracts of Abohar and Muktsar tahsils. They covered 743 she-camels. Similarly, the District Boards of Hissar and Gurgaon maintained on subsidy 8 camel stallions who covered 254 she-camels. The prevalence during the year of famine conditions prevented these operations from being extended to other areas. In the Mianwali district they had actually to abandon them due to paucity of funds.

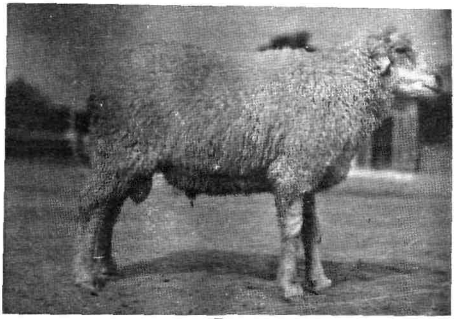
(c) *Sheep and Goats*

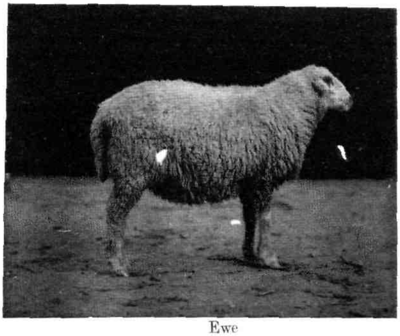
(i) *Sheep.* In the PUNJAB, the Bikanir sheep breeding scheme, which is being financed by the Imperial Council of Agricultural Research, completed its 2nd year. Satisfactory progress is claimed along all the items included in the approved technical programme. The following number of male lambs were issued for breeding purposes during the year :—

Punjab	75
Orissa	12
United Provinces	6
Central Provinces	6
Madras	3
TOTAL	102

BIKANERI SHEEP

Lamb (4 months)


Ram


Ewe

Flocks of Hissar-dale (Merino-Bikanir cross) and Lohi breeds of sheep are also being maintained by the Punjab Government at the Government Cattle Farm, Hissar. 98 Hissar-dale rams were issued for breeding purposes, particularly in Kangra district, where they are now being placed in the hands of non-migra-tory breeders. The following statement will indicate the average wool yield and price realized during the year, for the different breeds :—

Breed	Class	Average yield of wool for the whole year.	Price realized per lb.	
			1st clip	2nd clip
		Lb.	Rs. a. p.	Rs. a. p.
Hissar-dale	Rams	7·35	0 7 3	0 9 0
	Ewes	4·12		
	Lambs	4·16		
Bikanir	Rams	8·35	0 5 6	0 7 0
	Ewes	4·49		
	Lambs	4·82		
Lohi	Rams	4·60	0 5 10	0 6 3
	Ewes	2·27		
	Lambs	1·73 (one clip only.)		

The Rakh Dand sheep breeding scheme in the Jhelum district, which is being run on a co-operative basis and where a certain amount of land has been allotted on sheep breeding conditions is progressing favourably.

In Bombay, a scheme financed by the Imperial Council of Agricultural Research is now in progress. Report for the period 1st July 1938 to 31st March 1939 reveals that the Deccani sheep are being improved by selection and grading up. The imported Merino sheep are adapting themselves to the local conditions and the results of their crossing with Deccani sheep are being studied. The analysing of fleeces has also been taken up. A scheme for the improvement of the Bellary breed of sheep has been taken in hand in Madras from October, 1938. Preliminary arrangements, witb the object of evolving, if possible, a better type of this breed, by cross-breeding with Bikanir rams, have been completed.

To improve the sheep breeding industry in the Province, the Veterinary Department of the North-West Frontier Province is making full use of the Hissar-dale, Pusht-i-Koh and purebred Merino rams. A number of these animals have been located in selected districts where considerable improvement is claimed.

In Mysore, Merino rams and ewes have been imported from South Africa. Cross-breeding work is being carried on at Hebbal, Ajjampur and Yellachihalli Sheep Farms and improvement is being effected by issuing cross-bred rams to the sheep breeding associations in the State.

The Kolar sheep breeding association is making commendable progress. 129 new members were enrolled and the strength of sheep under its control is now 15,000. 19,911 sheep were shorn by machine. The improved wool was sold at 6 as. per lb., while the indigenous wool fetched only 4 as. per lb. Another sheep breeding association was started for the Mysore district during the year.

In ASSAM, the Bikanir sheep continue to flourish at the upper Shillong Farm. The average wool yields of rams, ewes and lambs were 7·38, 5·10 and 2·36 lb., respectively.

In the CENTRAL PROVINCES and BERAR, a sheep breeding farm has been started at Dhar as an experimental measure. Rams of Hissar-dale and Bikanir breed have been imported from the Government Cattle Farm, Hissar for cross-breeding with local ewes. Efforts are also being made to improve the local sheep by selection and grading up.

In ORISSA, six rams of Bikanir breed were purchased during the year and efforts are now being directed towards improvement of local sheep both by grading up and cross-breeding.

(ii) *Goats.* During the year under review, the scheme for the improvement of Jumna Pari and Barbari goats in the United Provinces was continued at the Goat Breeding Farm, Etah.

A considerable increase in the average milk yield of both the flocks was registered and there was a further improvement in the milk yield of daughters in comparison with their dams. A process for the manufactnre of sweet cottage cheese was standardized. The cost of production of milk was brought down to 7·2 pies per lb. There is now a very keen demand for the male kids of both the Jumna Pari and Barbari breeds from several provinces.

In the PUNJAB, systematic efforts to improve the Betal herd of goats at the Government Cattle Farm, Hissar were continued. Of the 127 goats which completed their lactation, 104 yielded more than 100 lb. of milk. With a view to improve the milk yield and size of local goats in the Province, 46 male goats were issued during the year to selected breeders at concession rates. The start of the scheme for the investigation of indigenous goat breeding at the Government Cattle Farm, Hissar, which was sanctioned by the Imperial Council of Agricultural Research, had to be postponed for a year owing to the continuance of famine conditions.

In the NORTH-WEST FRONTIER PROVINCE, goat breeding operations have been confined to the Peshawar and Kohat districts where seven male goats of the Jumna Pari breed were at work. During the year, two Angora bucks and four does were imported from U. S. A. for the development of the mohair industry in the province. Cross-breeding work has already been taken in hand.

Goat breeding is gaining in popularity in Assam and efforts are being made to import as many bucks of the Jumna Pari breed as possible. 17 Patmai he-goats were also purchased during the year and located in different areas.

In BENGAL, a scheme for experimental work on goat breeding is under consideration with the Government.

In ORISSA, the old flock of goats at Balia Farm was sold off and six goats of an improved type were purchased during the year.

A flock of Jumna Pari goats and bucks has been established at Makarpura in BARODA. The object is to issue pure bred animals of this breed to various centres in the State for the improvement of local goats.

CHAPTER X

VETERINARY EDUCATION AND INSTRUCTION IN DAIRYING, ETC.

1. Veterinary colleges

Madras Veterinary College

THE G. M. V. C. Diploma course having been extended to four years with effect from the academic year 1938-39, proposals for the extension of the B. V. Sc. Degree course, which is run in conjunction with the University of Madras, to a period of 5 years with effect from the same academic year were submitted to Government and they have approved the proposed extension. The Government have also approved the proposal to raise the minimum general educational qualification for admission to the Diploma course of the College, which has accordingly been fixed as a pass in the Intermediate examination, with Chemistry or Natural Science as one of the optional subjects, for candidates from all communities other than Muslims and scheduled classes. For these communities a pass in the S. S. L. C. examination with Chemistry as the optional subject is required. The number of students admitted to the college was the same as last year, viz. 40 from the Madras Province and 10 from outside. The strength of the first year class including the failed students was 51. Seven students (six for the Degree and one for the Diploma course) from outside the Madras Province were admitted to the college during the year under review. At the end of the year the number of students on the rolls in all the three classes was 126 (50 in the first year, 47 in the second year and 29 in the third year) as against 118 of last year.

The four scholarships allotted for the first year were distributed to one Muslim, one Christian and two members of the Non-Brahmin, backward classes.

At the annual examination of the Diploma course of the college, of 50, 46 and 29 students who appeared from the first year, second year and third year classes respectively, 30, 25 and 20 passed the examination. The B. V. Sc. Preliminary and Intermediate examinations were held in May and August 1938. Of the 32 and 6 students who appeared for the whole and part Preliminary examinations respectively in May 1938, 11 secured a full pass and 5 passed the part for which they appeared. In the Intermediate examination held during the same month 17 appeared and 7 secured a full pass. In August 1938 examinations for the B. V. Sc. Preliminary, of the six students who appeared for the whole examination and 18 who appeared for part examination, two and twelve passed respectively. In the Intermediate examination, of the five students who appeared for the whole examination one secured a full pass and of the eight students who appeared for the part examination seven passed the part for which they appeared.

Bombay Veterinary College

There is still a great demand for veterinary graduates and all students who graduated during the year under review found employment shortly after graduation.

There were 138 students on the 1st April 1938. The annual professional examinations were held in April as usual. There were 129 students of whom 55 were declared successful. Of these, 12 who passed the final year (Diploma) examination left the college and 13 discontinued the course. The remaining 113 students continued and remained under instruction. In June 1938, 34 new students were admitted to class A, and 1 to class B, thus making a total of 148 students at the college at the commencement of the college year. Of these six students left the college on passing the supplementary final year (Diploma) examination in October and three students left subsequently during the middle of the year. There were thus 139 students at the end of the year as against 138 at the commencement. Of the 35 new admissions in June 1938, 26 were natives of the Bombay Province, 3 from Sind, 1 from the Nizam's Dominions, 1 from Kolhapur, 1 from Ramdurg, 2 from Jodhpur and 1 from Africa. One had passed the B.Sc. (Agri.) examination, two Intermediate Science, 16 First Year Arts and the remainder were Matriculates. At the annual examinatious, of the 53, 39 and 37 students who appeared from class A, class B and class C, 24, 19 and 12 passed the examination respectively.

Of the nine Government scholarships available at the college, three scholarships were vacant, two scholars having graduated and left, and one scholarship was withdrawn as the scholar failed at the annual examination and these were awarded to the three new students in class A. Two scholars left the college during the year. There were thus seven Government scholarship holders studying at the college at the end of the year.

The Government of Sind sent three new scholars and continued stipends to three scholars already in the college. The Kashmir Government continued stipends to their five scholars. The Kotah State continued stipends to their four scholars. The state of Jodhpur sent two new scholars and the states of Kolhapur and Hyderabad sent one scholar each. The states of Bikaner, Cambay, Udaipur, Indore, Mysore, Rewa and Dewas and Federated Malay States continued stipends to their scholars. Thus out of the 139 students, 34 held stipends and 105 were private students.

The college continued to have a full complement of students. It is stated that an improved course of training will be introduced in the near future.

Bengal Veterinary College

During the last few years an increasing demand has been made for admission to the college from the various provinces in India, especially from the United Provinces, the Punjab, Assam and also from outside India, e.g. Burma, Ceylon, the Federated Malay States and Iraq, but owing to the gradually increasing number of Bengalis required for the province and the limited accommodation in the hostels and classes, more admissions are now being granted to Bengalis to the exclusion of foreign students.

At the beginning of the season, i.e. in July 1938, 210 students were on the rolls of the college, of whom 204 continued their studies throughout the season as against 207 in the preceding year ; six left on account of financial difficulties or for other reasons. There were 68 in class A, 67 in class B and 69 in class C ; 67 fresh students were admitted in class A during the session and 35 failed students were readmitted in all three classes. Out of 204 students remaining at the end of the session, 87 held stipends from various bodies and 117 were

private students. The district boards of Bengal awarded 40 stipends during the session 1938-39 against 35 in the previous year.

Of the 66, 66 and 69 students who appeared for classes A, B and C examinations, 54, 55 and 53 passed respectively.

Punjab Veterinary College

During the year 283 candidates applied for admission and 87 were admitted to the college. Their academic qualifications were B.Sc. 2, B.A. 1, F.Sc. (Medical) 29, F.Sc. (Non-medical) 18, F.A. 25 and Matric (1st division) 12. Of these 42 were agriculturists. At the annual examination held in June 1938 and the supplementary examination held in September 1938, of the 86, 63, 41 and 12 students who appeared from the first year, second year, third year and fourth year classes respectively, 71, 55, 32 and 11 were declared successful. Those who passed the fourth year (final) examination were awarded the Diploma.

The supply of veterinary graduates still falls short of the demand in the Punjab and the northern Indian States. It is, however, hoped that the position will improve in the near future.

Bihar Veterinary College

Forty-six new students joined the college as compared with 38 in the previous session, while 55 out of 63 old students returned for further studies, making a total of 101 at the beginning of the session. The new admissions comprised one Bihar Government stipendiary, two Orissa Government stipendiaries, six North-West Frontier Province Government stipendiaries, 18 United Provinces Government stipendiaries, two Jodhpur State stipendiaries, six Bihar District Board stipendiaries and 11 private students (viz. ten from Bihar and one from the United Provinces). Two private students of the College were awarded stipends by the Purnea District Board and the Bettiah Raj. None of the newly admitted students left the College during the course of the session.

A revision class was started by Government for the first time in January 1939. Eight failed students of class A, who were not recommended for readmission by the Governing Body on account of their unsatisfactory progress, were permitted to join this class on payment of a consolidated fee of Rs. 35 each; seven of them joined and the numerical strength at the end of the session was thus raised to 108. Of the total number (108), 50 were private students and 58 stipend holders.

The annual and diploma examinations were as usual conducted by a Board of Examiners duly constituted by Government and the results were found to be satisfactory. Altogether 107 students (viz. 56 in class A, 25 in class B and 26 in class C) appeared at the examinations and of these 90 passed, viz. 48 in the first year, 20 in the second year and 22 in the third year, the percentage of passes being 85·7, 80·0 and 84·6 as compared with 63·6, 81·8 and 68·0 in the preceding year.

2. Post-graduate courses in veterinary science

Eleven officers attended the annual post-graduate refresher course held at the Imperial Veterinary Research Institute, Mukteswar, in 1938, viz. two from the Punjab, two from Bombay, two from Orissa, one from Jodhpur State, one from Jammu and Kashmir State, one from Bengal, one from the North-West Frontier Province and one from the United Provinces. In addition,

twelve officers received practical training at the Institute for different periods during the year.

At the Madras Veterinary College, the refresher course was held as usual during the year from July 1938 to March 1939. Eight students underwent the course, of whom six were from the Civil Veterinary Department, Madras and two from the Veterinary Department, Hyderabad. Towards the end of the year, these students were examined by a Board of Examiners.

At the Punjab Veterinary College, only one Veterinary Assistant from the district cadre joined the refresher course during the year.

At the Bengal Veterinary College, one of the graduates of the college of the year 1937-38 attended the practical extension course sanctioned by Government till he secured an appointment in the Allahabad Agricultural Institute.

3. Indian Dairy Diploma

At the Imperial Dairy Institute, Bangalore, 23 students, who were admitted in November 1937, continued to receive training during the year. In addition, four repeat course students, who had failed in the previous final examination for the Indian Diploma in Dairying at the Allahabad Agricultural Institute, were admitted during the year so that they could resit for the final Diploma examination at Bangalore. The I. D. D. students also received training in agricultural and cattle-breeding work at the Agricultural Sub-station, Karnal, for a period of 2½ months and had instructional tours covering over 40 dairy and cattle-breeding institutions in different parts of the country as a part of their training.

Out of the 26 candidates who sat for the final I. D. D. examination at the Allahabad Agricultural Institute in December 1938, 21 passed and were awarded the Diploma.

The question of making the Punjab Agricultural College at Lyallpur a centre of training for the Indian Diploma in dairying is under consideration. The dairy herd and other facilities provide an equipment for such training, but various additions will be necessary if the proposal is to materialize.

4. Post-graduate course in dairying

At the Imperial Dairy Institute, Bangalore, seven post-graduate students, admitted in January 1938, completed their training in March 1939. In addition to the training at Bangalore, they were given training for about a month and a half at the Agricultural Sub-station, Karnal and the Imperial Agricultural Research Institute, New Delhi. They also undertook instructional tours to different dairy and cattle-breeding institutions in the country. A new class of nine students was opened in January 1939. These students were under training at the close of the year.

5. Short courses

(a) *Dressers, Farriers, Compounders, Stockmen, etc.*

The Principal, Bombay Veterinary College, conducted the examination of farriers who had received instruction in this art. Eleven candidates who appeared for the examination were declared successful.

At the Bengal Veterinary College, one man attended the farrier's course and was granted a certificate after completion of his training. Eleven men attended

the Dressers' course and were granted certificates after completion of their training. Five men attended the Veterinary Dispensing Course and were awarded certificates after the completion of their training. Twenty-two outside candidates attended the Riding School during the year under report. Eighteen stockmen deputed by the Livestock Expert, Bengal, received instruction regarding cattle diseases.

In the United Provinces, the compounders' training class having been suspended during the year, a six months' course was started at the Research Station, Lucknow, for training stockmen in elementary veterinary science, animal husbandry, first-aid, etc. Seventeen men qualified and have been appointed in the different districts as assistants to the subordinate veterinary staff in connection with rural development work.

At the Punjab Veterinary College, 56 candidates joined the Dressers' class and successfully completed the course. Sixteen candidates joined the Farriers' class in September 1938. Of these thirteen were deputed by the Military Adviser-in-Chief, Indian State Forces, two were private students and one was sent by Sabar-Kantha Agency, Sadra. Thirteen men passed during the year under report. Two short courses of five weeks' duration for the training of syces were held at the Government Cattle Farm, Hissar, in May-June 1938 and November-December 1938. Eight syces, seven at the first and one at the second course were trained. With a view to meeting the urgent need of the province, the Punjab Government sanctioned during the year the starting of two courses, i.e. one for stock assistants and one for veterinary compounders, each of six months' duration at the Government Cattle Farm, Hissar.

In the Central Provinces, Compounders' classes were held at the four divisional headquarters dispensaries, viz. Nagpur, Jubbulpore, Raipur and Amraoti. Fifty students were admitted during the two sessions held, one from 1 April to 30 September 1938 and the other from 1 October 1938 to 31 March 1939. Thirty-three candidates passed the prescribed test and were awarded certificates.

In Orissa, a class for the training of stockmen was held for ten months during the year. Twenty-five candidates were admitted with stipends, of whom seven dropped out. The training consisted of theoretical and practical training in cropping fodder, making compost and silage and in veterinary practice including inoculation and castration and treatment of simple diseases.

In Hyderabad State, a batch of 35 headmasters from primary schools and a batch of students from Himayatsagar Farm, who were deputed for training, received lectures on veterinary matters.

In Mysore, Government sanctioned a scheme for training the Departmental compounders and young men of the state with an aptitude for animal husbandry work, in treating common ailments affecting cattle, castration of animals and care of animals in sickness and in health. This scheme provides for holding two sessions, each of four months' duration, to train five men of the Department and 15 other pupils in each batch.

(b) *Dairying*

Special short-period courses were held at the Imperial Dairy Institute, Bangalore. Twenty-two students were admitted to these courses during the

year and received training for periods varying from one to eleven months. Some of the candidates who had not completed their training were still at the Institute at the end of the year under report. In addition to these courses of instruction, 90 Indian soldiers were given facilities, on two occasions, to acquire a general insight into the various activities of the Institute in connection with their rural reconstruction training.

At the Punjab Agricultural College, Lyallpur, a short course in dairying was held during the year and was attended by ten students.

(c) *Poultry*

In Bombay, a poultry-farming course was held under the Livestock Expert to Government at the Government Central Poultry Farm, Kirkee, and was attended by 57 students from practically all over the province. In addition, special district courses in poultry-farming were organized at different centres of the province.

In the United Provinces, the United Provinces Poultry Association, Lucknow, trains students in poultry-keeping and marketing of poultry products in the following courses :

Diploma course,
Advanced course,
Elementary course and
Farmer's course.

The total number of candidates trained during the year was 20, of whom 15 were in the Elementary course, three in the Advanced course and two in the Diploma course. Seven candidates were trained at Government expense under the United Provinces Unemployment Relief Scheme, one was on deputation from the Rural Development Association, Jaunpore, four were trained free by the Association and eight were private individuals who paid full tuition fee. Of the 20 candidates who appeared for the examinations, 17 were successful.

In the Punjab, the usual courses of instruction in poultry-keeping were given to the Degree classes at the Agricultural College, Lyallpur, and to agricultural assistants employed on district work, as well as to the outside public at the Poultry Farm, Gurdaspur. Nineteen members of the public underwent the two weeks' course.

CHAPTER XI

DISTRICT WORK

THE benefit of agricultural research will be derived by the cultivator only if an attempt is made to show him how to apply experimental results to practical agriculture. In various provinces methods suited to local conditions have been devised to bring home to the farmer the lessons of scientific research. As a result of the recommendations of the Royal Commission on Agriculture and latterly Sir John Russell's recommendations on bridging the gap between research and the farmer, there has been an intensification of agricultural propaganda. A great impetus to the movement has also been received from the central grant for rural development and the rural uplift schemes put into force in practically all British provinces and a number of Indian states.

In BOMBAY, a provincial board for rural development was established with corresponding district boards in each district. These boards are largely non-official in composition and advise the provincial government on all matters relating to rural development within their jurisdiction. The Agricultural and Cooperative Departments have been reorganized and a new Rural Development Department has been set up, in charge of district demonstration and propaganda organization, of seed and implements supply, etc. of which the Agricultural Department has been relieved. These activities are to be intensified and extended through cooperative agencies in the districts. Taluka demonstration centres and honorary agricultural agents in the districts will be directed in their work by the Rural Development Department. The Agricultural Department, however, will remain closely associated with the work of agricultural propaganda and service through the Provincial and District Rural Development Boards.

In this chapter it is proposed to give a brief summary of the activities during 1938-39 in the sphere of agricultural propaganda under the following heads: (1) Demonstrations, (2) Other forms of propaganda, (3) Agricultural shows and exhibitions, (4) Agricultural associations, (5) Seed multiplication, (6) Implements, (7) Fertilizers and (8) Animal husbandry.

As compared with 1937-38 there was, throughout India, a considerable increase in the number of demonstrations of improved agricultural practices.

1. Demonstrations

In MADRAS, there were 8,740 demonstration plots in the ryots' lands as against 7,963 in the previous year. In these plots the various improvements advocated by the Agricultural Department, especially the cultivation of paddy, cotton, sugar, *cholam*, *ragi*, groundnut and tobacco and methods adopted to control insect pests and plant diseases were demonstrated. In the Vizagapatam district the special scheme of intensive propaganda was in its fourth year. In this district the demonstration *maistries* did intensive work in 360

villages, and improved implements were extended to 1,075 villages. Each *maistry* got into touch with 20 villages on the average against 18 in the previous year. The acreage under improved varieties and strains of paddy increased from 1,00,240 acres to 1,98,845 acres.

Some of the practices demonstrated throughout the province were reduction in the seed-rate of paddy in nurseries and transplanting of seedlings in singles and doubles, ridge-sowing of Cambodia cotton (which shows a profit of Rs. 4 per acre over the common practice of sowing on flat beds), the planting of sugarcane with greater spacing between the rows and inter-cultivation with bullock-power, the sowing of groundnut seeds in every furrow instead of in alternate furrows, contour planting, and manuring and grading of potatoes. Results indicate that more and more cultivators are adopting the improvements shown to them.

In BOMBAY, over 2,200 demonstrations were given in the North-central and Central Divisions. In the Southern Division similar work was carried out by the district staff at about 350 centres—field plots and taluka agricultural demonstration centres. In addition, several local training classes in *bunding*, horticulture, *gur*-making, etc. were held. In Gujarat parties of cultivators were taken periodically to the taluka agricultural demonstration centres where they were shown improvements practised on selected plots. Similar demonstrations were organized at the Cotton Breeding Station at Broach and at Government farms.

In BENGAL, the principal demonstration agency is the Union Board Farm and Demonstration Centre. In 1938-39, in the Eastern Circle, 35 union board farms and 100 demonstration centres were opened and a sum of Rs. 9,866 was spent on them. Union board farms are areas all in one block if possible, and run by one man, on which it is endeavoured to show on a fairly large scale what benefits can be obtained from departmental seeds, implements, manures and practices. Success depends not only on the selection of a site with a good advertisement value, but even more on the cultivator owner, the energy and character of the demonstrator, and of course on the weather. The same factors apply to the demonstration centres. Each demonstration centre is made up of a group of 6 to 20 cultivators all of whom get some seed. The same seeds are not given to every man in the group ; for example out of 10 men only 4 may grow paddy. Each is expected to grow crops as instructed or shown and to share his small harvest with friends not in the group. Each union board farm owner was given a grant of Rs. 50 with which to build or help to build a *gola* or seed store in which he was expected to store his harvest of paddy for sale as seed. In the Western Circle, 37 new union board farms were organized and a sum of Rs. 6,103 was spent. Also 103 demonstration centres were started during the year. In the Northern Circle, a new development is the increasing number of private farms which, started by the educated unemployed, remained in touch with the Agricultural Department and consented to grow crops recommended to them. There are 59 of these farms serving as a link between Government farms and the rural public in the automatic spread of improved and recommended crops and improved methods of cultivation. They grow recommended crops, practise improved methods, and distribute surplus seed to neighbouring cultivators. In this Circle, 24 union board farms and 82 demonstration centres were established in 1938-39.

In the UNITED PROVINCES, the organization of rural propaganda is by means of six circles each under a Deputy Director of Agriculture, together with a Cattle Breeding Section and an Agricultural Engineering Section.

A large number of private demonstration farms work in cooperation with the Agricultural Department for the purpose of demonstrating improved agricultural practices. These farms are on the increase. For example, in the Sarda Circle the number of such farms increased from 8,992 in 1937-38 to 13,016 in 1938-39. The demonstrations include improved seeds, improved methods and improved implements as against the local practice. The improved methods include green manuring, compost-making, manure pits, double cropping with a leguminous crop or paddy under canal irrigation followed by wheat or barley sowing in lands and inter-culture. The agricultural staff working in cooperation with the Irrigation Department has made headway in the introduction of fodders under irrigation. An original scheme to develop some 200 acres of poor and partly *usar* land and to provide healthy occupations for criminals on a cooperative basis was initiated by Mr C. Maya Das. Funds have been sanctioned partly as a grant-in-aid and partly as a loan through the U. P. Cooperative Union for the Arya Nagar Criminal Settlement Cooperative Farming Society some eight miles from Lucknow. The scheme has so far been successful, and about 70 families of criminals are working enthusiastically, raising crops and earning an honest living under the guidance of the Department. There is an increasing tendency on the part of private farmers to consult the Department, and in the Western Circle, for example, the number of private farms advised and assisted by the circle staff rose from 368 to 467 in 1938-39. The state tube-well scheme, launched in 1935, in the districts of Meerut and Moradabad and financed by a grant from the Government of India sugar excise fund, made good progress. The circle staff remodelled 4,106 acres under wheat and sugarcane during the year and distributed 35,926 mds. of improved seeds of sugarcane and 4,650 mds. of improved wheat seed. The area is divided into development zones each consisting of the area commanded by 26 tube-wells. One *kamdar* looks after three tube-wells in nine villages. The main work consists of remodelling the holdings and consolidation of cropping. Side by side intensive improvements in agricultural practice were introduced in seed union farms. The rotation of crops aimed at is sugarcane—ratoon—wheat—*sanai*—or other *kharif*—covering four years. Green manuring was encouraged by the supply of 457 mds. of *sanai* seed at the specially reduced rate of Rs. 2 per md. Winter leguminous fodders were encouraged by supply of berseem and lucerne seeds. Compost-making was demonstrated and 774 manure pits were dug in the zonal area. In the Eastern Circle the departmental staff was able, by large-scale demonstrations on cultivators' fields, to persuade the cultivators of 300 villages to abandon sowing *desi* wheat in favour of improved Pusa wheats. Demonstrations of groundnut sown in lands between rows of *arhar* 9 ft. apart were made on an extensive scale; 16,006 field and 35,333 manurial demonstrations were laid down on the cultivators' own fields in the Eastern Circle. In the Ghagar canal area, where *rabi* cultivation is difficult owing to the *karail* (hard and sticky clay) soil which remains wet till late in October, 1,084 field and manurial demonstrations were laid down, 2,081 mds. of seed distributed and 22 implements sold. In the Eastern Circle the number of demonstrations on the cultivators' fields rose from 600 in 1937-38 to 8,345. There was a severe

outbreak of red-rot in the Gorakhpur, Basti and Gonda districts. A vigorous campaign was organized in which sugar factories cooperated. Government provided a sum of Rs. 25,000 and the sugar factories agreed to bear half the cost of subsidizing seed supply. The damage was so wide-spread that unfortunately good disease-free seed was not available in sufficient quantities. An area of 3,000 acres was, however, cleared and sown with disease-free seed supplied by the department. The measures were successful and there was no recurrence of red-rot in the areas where the campaign was organized, though elsewhere the disease broke out again in the following season. In the Bundelkhand Division cooperation with the Rural Development Department resulted in appreciable improvement in rural conditions. During the year 28,314 manure pits were dug, 2,085 urine preservation beds were made, 434 irrigation wells were constructed, 300 *bandhis* were made, 2,733 fruit trees were planted, and 406 better-living societies were organized.

In the PUNJAB, particular attention was given to demonstration plots in cultivators' lands in which improved seed is sown or new methods practised side by side with the old. In 1938-39 there were 7,238 plots as against 5,433 the previous year. This is an increase of 30 per cent. Further developments depend upon expansion of the staff. The aim is to provide a permanent district subordinate establishment on the basis of a minimum of one agricultural assistant and two *mukkadams* per tahsil. The contribution of the Agricultural Department to the rural development scheme adopted in 1937 consists in strengthening the existing staff so that every district, tahsil and village may be covered.

In the CENTRAL PROVINCES, the special feature of the year was the inauguration, early in April, of the Vidya Mandir Scheme drawn up by the Prime Minister. The Agricultural Department was entrusted with the task of examining all offers of land in connection with the scheme with a view to determining whether they will be capable of yielding an income sufficient to support the Vidya Mandir teacher. There were 398 offers of which 98 were recommended for final acceptance. Arrangements were made for the purchase of livestock and implements and the construction of farm buildings and as much as possible of the land was cultivated without delay. The Vidya Mandir farms are expected to develop into ideal demonstration centres and act as a powerful influence in raising the standard of agriculture in the neighbourhood. In the Northern Circle the number of private demonstration plots rose from 24 to 34 during the year. In this Circle 1,803 and in the Eastern Circle 4,263 demonstrations were carried out by the staff to show the advantages of the different items of propaganda. Improved methods of planting sugarcane were demonstrated at 242 centres. The sugarcane under Government tanks in the Bilaspur district went up by 150 acres due to the high prices of *gur*. Silage-making demonstrations were arranged at 51 centres. Under the Maniari and Hardi tanks the sugarcane area reached its peak in 1937-38 but declined subsequently. One of the chief causes of the decline is the difficulty experienced in getting cane crushed in time.

In ASSAM, a sum of Rs. 60,500 was spent on demonstrations as against Rs. 66,000 in the previous year. As before, the recommended strains of paddy maintained their superiority to the local varieties. In the Upper Assam Valley demonstrations were made for the first time with improved strains of *aman*

paddy evolved at the Deep Water Paddy Research Farm, Habiganj. As a result of propaganda and demonstrations, more and more land is being cultivated with improved strains of paddy which covered an area of 59,089 acres of land out of a total acreage of 5,351,506 under paddies of all kinds. Demonstration with the cultivation of *boro* paddy in precarious *aman* paddy lands under irrigation by means of power-driven pumps begun in 1935-36 was continued. A bund was put up in a perennial rivulet near Kayasthagram in Sylhet and with the water impounded thereby about 140 acres of land were successfully cropped with *boro* paddy, potato, chilli and brinjal. Two sluice gates were constructed in two other places and a total area of about 550 acres was improved. The acreage under improved sugarcane fell from 17,500 acres to 13,153 acres owing to a fall in the price of *gur* at the beginning of the year. Nevertheless, demonstrations with improved varieties were conducted. In the Surma Valley the average out-turn from the Co varieties was 3,759 lb. of *gur* per acre. Demonstrations were also given on improved furnaces and other appliances for manufacturing *gur*. Demonstrations were also given in the districts of Sylhet, Kamrup, Darrang, Nowgong and Goalpara, on jute cultivation, washing, retting, etc. Fruit growing was encouraged by help in marketing fruit and reduction in steamer and railway freights obtained by the Department.

In ORISSA, 27 subsidized farms were opened with a view to demonstrating on cultivators' lands the value of plant cropping. In 380 demonstration villages cultivators were given seeds and manures free and encouraged to adopt all improvements. The total number of demonstrations was 9,341 against 5,844 in the previous year.

In HYDERABAD, the total area under new and improved varieties of crops introduced by the Agricultural Department amounted to 4,17,022 acres. Though other means of approaching the cultivator and inducing him to follow the improved practices are adopted, such as printed literature, lectures, shows and exhibitions, and radio talks, reliance is placed chiefly on demonstration plots in villages. There were 3,688 demonstration plots belonging to cultivators to whom seed, manures or implements were supplied free. At one time Co 213 was the predominant sugarcane variety in all the districts. As a result of experiments it was found that Co 290 and POJ 2878 were still better and their introduction was started. They have now spread in most of the areas under sugarcane. Other improved varieties being recommended in the State include the Spanish Peanut and Kanke No. 17 among groundnuts which occupied 1,98,961 acres in 1938-39, the Cawnpore awned variety of *bajra* (2,998 acres), Himayatsagar No. 263 rice (6,613 acres), four varieties of cotton, the most important being Gaorani No. 6 (2,41,653 acres) and Pusa No. 4 wheat (4,463 acres).

In MYSORE, the demonstration plots in cultivators' fields increased from 1,933 to 3,551 in 1938-39. The yield of these plots was higher than that in the rest of the holdings and consequently a very favourable impression was gained everywhere.

In BARODA, the scheme of demonstration with the help of Intensive Units made further progress. The propaganda aimed at the introduction of better varieties of existing crops and better means of handling them, the improvement of the local supply of manure and the implement outfit at the farmers' disposal. Associated with the demonstration of the newer seed and methods

to the satisfaction of the farmer is the necessary organization to provide the seed, working materials and implements of which demonstration proved to be effective. There were 351 villages in the State which were covered by these Intensive Units. Demonstration plots were not yielding successfully owing to unfavourable weather and sometimes due to the carelessness of the farmer who had undertaken the demonstration. In the Northern Circle an interesting development is the marked increase in acreage following on the demonstration of the use of sulphur against mildew in cumin and also the faith placed in the reliability of the stock of sulphur dust sold by the Department. There was sale of 23,600 lb. from the State depots. This new farming practice added approximately a net Rs. 12-8 per *bigha* in quantity and quality. In the Southern Circle the great drive in both Baroda and Navsari was against the stripped cotton bollworm. A total of 6,09,773 *bighas* were under propaganda. As against 2,371 in the previous year 4,517 pullers were sold. For the destruction of the spores of *jowar* smut fine sulphur dust was sold in packets of 4 oz. at half an anna.

In TRAVANCORE, it was decided to stop the system of conducting diffused demonstrations in small plots at numerous centres for varying periods of time and to select an ideal holding of five acres in each taluka where improved methods of cultivation should be carried out for a period of five years with the help of the additional staff recently sanctioned. The owners of such holdings are to defray the expenses of cultivation but manures would be supplied gratis by the Department, and improved ploughs lent free of cost. The local Agricultural Officer and the owner of the holdings are to maintain accounts. Seed is to be multiplied and distributed, a model manure pit is to be constructed and compost-making is to be demonstrated. *Ragi*, vegetables, green manure, fodder plants and fruit trees are to be encouraged. Cash bonuses are to be awarded to ryots who produce outstanding crops. Subsidiary occupations like bee-keeping and poultry are also to be encouraged. The castration of scrub bulls and the maintenance of stud bulls are to be carried out. The Agricultural Department advanced the money needed for manufacturing and distributing 300 beehives to the Rural Reconstruction Centre, Marthandam. The hives are being sold to villagers at the cost price of Re. 1-9.

2. Other forms of propaganda

India is a land of villages which are scattered over vast expanses of the countryside. To show them the improvements advocated by the Agricultural Department, motor vans and other mobile units equipped with magic lanterns and similar appliances have come increasingly into use. Generally speaking, the present tendency is for the cinema and the radio, owing to their superior effectiveness, to replace the magic lantern and the gramophone.

In MADRAS, 2,012 lectures, as against 1,243 the previous year, with and without the aid of magic lanterns, were delivered during all exhibitions, *jamabandi* camps and conferences. Twenty-three radio talks on agricultural topics were broadcast in Tamil, Telugu and English.

In BOMBAY, the staff of the Agricultural Department contributed numerous articles dealing with subjects of local agricultural interest to publications in

the districts. In addition, the services of the district staff were frequently called in for lectures at public meetings and gatherings of cultivators.

In BENGAL, there were 732 magic lantern lectures by the officers of the Agricultural Department, which were well attended. Even more popular were the cinema films on agricultural activities arranged through the Publicity Department of the Bengal Government. A short play named *Jagaran*, a *tarza* specially recorded for the jute restriction campaign, and a cinema film, *Bhuler Phasal*, written by Rai Debendra Nath Mitra Bahadur, Special Officer, Jute Restriction Scheme and Propaganda Officer of the Agricultural Department, were the successful enterprises of the year.

Jute restriction propaganda continued unabated, helped by four special demonstrators appointed in the Northern Circle during the year. With the cooperation of district agricultural officers, sub-divisional officers, circle officers and presidents of union boards, organized meetings and lantern lecture shows were held to explain to the jute growers the necessity for restricting the area and for growing substitute crops. In fact, combined efforts were made by officers of all departments in carrying out vigorous propaganda. *Aus* paddy, *jowar*, *rahar* and sugarcane cuttings were distributed.

In the CENTRAL PROVINCES, 56 lantern and cinema lectures were given in the Northern Circle and 'Farmers' Days' were held at Government farms and demonstration plots. In the Southern Circle cinema shows were given at Ramtek during the annual fair, at Chindwara during a gathering of teachers and students of district council schools, and at Nagpur. In the Western Circle magic lantern lectures and cinema shows were given at 255 centres.

In ASSAM, lectures were delivered and leaflets distributed to cultivators. The annnal Farmers' Day at the Upper Shillong Farm was presided over by Sir Robert Reid, Governor of Assam and was a great success. In BALUCHISTAN, four popular leaflets relating to the control of crop pests were published.

In HYDERABAD, the propaganda channels are lectures, plays, broadcast talks by officers of the Department, leaflets, and a quarterly magazine, *The Hyderabad Farmer*.

3. Agricultural shows and exhibitions

Agricultural shows and exhibitions are important events in the countryside which attract the farming population and offer them opportunities of acquainting themselves with the latest developments in husbandry. They are held at suitable seasons of the year. The more important are dealt with below.

In MADRAS, exhibitions and shows were held during fairs and festivals, conferences, health week celebrations and *jamabandi* camps. They totalled 379 as against 352 in the previous year. An annual exhibition from the middle of December 1938 to the middle of January 1939 was held at the Congress House, Madras, under the auspices of the All-India Khadi and Swadeshi Exhibition Committee. Another exhibition lasting a fortnigh, from 24 December 1938 was held in the South Indian Athletic Association's ground in Madras in connection with the annual Park Fair. In both exhibitions all the circle officers and heads of research sections took part and sent useful exhibits and deputed their assistants to explain or demonstrate them. The Second Cudappah District Agricultural Exhibition was held during the year and from the surplus funds a rubber-tyred bullock exhibition van was purchased for touring in the district.

In BOMBAY, the Agricultural Department organized the agricultural section of the Second Trades and Agricultural Exhibition in Surat district. It included *stalls for horticulture, improved seeds, manures, insecticides, land development,* marketing and improved implements. Practical demonstrations of improved agricultural methods were held in cooperation with village improvement committees.

In BENGAL, the Department contributed a sum of Rs. 2,250 to 40 exhibitions. Besides financial aid, the Department took part in exhibitions by displaying models, charts and exhibits and also by arranging lectures with and without magic lantern slides, practical demonstrations of ploughing, silage-making, making of artificial farmyard manure, grading eggs, cigar making, extraction of flax, working of cream separators and butter-making. The Government awarded prizes in the form of improved implements, seeds, fertilizers, etc. to the value of Rs. 250 per district. In this scheme 32 exhibitions cooperated and a total sum of Rs. 6,450 was spent as grants to exhibitions for this purpose.

In the UNITED PROVINCES, the agricultural staff attended fairs and exhibitions and distributed leaflets and pamphlets. For example, in the Sarda Circle there were 36 fairs and exhibitions ; in the Western Circle 79.

In the PUNJAB, the headquarters experimental stations hold a Farmers' Week once a year. On these occasions special arrangements are made with the railway administration for the transport of cultivators at concession rates. At the farm itself temporary camp accommodation is often arranged and the visitors spend a day or more according to the time at their disposal in seeing and learning something of the experimental work in progress and of the results of experiments already completed. Other departments also utilize these functions for the furtherance of their propaganda. At the six centres where Farmers' Weeks were held about 40,000 cultivators attended. The military authorities displayed much interest at those centres where troops were stationed, and one day during the week was allotted specially for the military rank and file.

In the CENTRAL PROVINCES, a special agricultural exhibition was organized at Tripuri during the session of the Indian National Congress. Almost all sections of the Department cooperated and the exhibition was a distinct success. In ASSAM, the Department of Agriculture took part in 11 exhibitions of which one was in the Surma Valley, five in the lower Assam Valley and five in the upper Assam Valley. The livestock section participated in eight exhibitions and the livestock inspectors delivered a number of lantern lectures on animal husbandry. In ORISSA, the Department took part in the exhibition at the Ravenshaw College in connection with the commemoration day and arranged various practical demonstrations. A combined agricultural and cattle show was held at 15 district centres. A sheep show was held at Tangi in the district of Cuttack where the Agricultural Overseer was directed to deliver lectures on the feeding and rearing of sheep.

In BALUCHISTAN, an agricultural show was organized at Usta in March 1939 and it attracted great attention. A lecture was given on locust control, and a zamindar who had tried *shaftal* and berseem explained the advantages of these crops.

In HYDERABAD, the annual horticultural and poultry show was held at Hyderabad from 27 to 29 January 1939. A rural development exhibition was held at Patancheru in March 1939. The Department also took part in the industrial exhibition held at Poona in March. Demonstrations on departmental farms are now a regular feature of the year's activity. The object of these demonstrations is to offer opportunities to cultivators to see the improved methods of farming and experimental work in progress in various sections of the Department. Selected cultivators are invited from neighbouring villages and conveyed free of charge. These demonstrations were held at the departmental farms at Sangareddi, Rudrur, and Raichur and at the aided farm at Bhir. A similar demonstration was held at Khammat on the occasion of the health week celebrations. There were, besides, 67 small shows held in conjunction with the *urses*, *jathras*, etc. A play, *Premi-kisan*, was staged in Kanarese at the Raichur demonstration by the Farm staff and in Telugu at the Sangareddi demonstration. At these demonstrations samples of produce are received from cultivators and useful implements, seeds and manures are awarded as prizes.

In BARODA, a very satisfactory display of tomatoes was put up at the Khanderao Market and fruit products were exhibited at a stall at the rural industries exhibition held at the time of His Highness's Coronation. An interesting feature of the year was the series of specially conducted visits to places of agricultural interest made available to farms of the better-farming societies. Parties were taken to the State tube-well areas in the United Provinces, to the Imperial Agricultural Research Institute, New Delhi, and to the government and other farms near Meerut.

In TRAVANCORE, the Department took a prominent part in the Sri Chitra Exhibition held at Trivandrum during the celebrations in connection with His Highness's birthday. The agricultural sections were among the most successful in the exhibitions and attracted all visitors. A large number of grafted fruit seedlings, selected seeds, etc. raised in the departmental farms were disposed of at the stalls. At Manavalakuruchi, an exhibition was organized by the Harijan Seva Sangh to which the Economic Botanist and the Agricultural Inspector, Paddy Farm, Nagercoil, sent a number of interesting exhibits.

4. Agricultural associations

There are numerous agricultural associations with a variety of functions, and in this review only a few can be covered and those newly organized.

In MADRAS, special efforts were made in the Second Circle to start as many agricultural advisory committees as possible, and no fewer than 365 such committees were organized. They have created much interest among cultivators in all matters pertaining to rural development. In the Fourth Circle an agricultural association was formed at Unai in North Arcot district to spread agricultural improvements, and a demonstration *maistry* was stationed for this work. It purchased from the department 55 ploughs, 2,60. lb. green manure seeds, 2,400 lb. of paddy and other seeds, 5,000 sugarcane seeds, 143 seed coconuts and one Kangayam breeding bull. There are now 40 sugarcane cultivators against three before the association was started. An event worthy of note was the starting of the Koya Uplift Scheme to improve the economic condition

of the Koyas in three villages in the Badrachalam taluka of the east Godaveri district. Two improved ploughs were supplied for their common use. Two ryots were selected from each of the three villages and they were given a pair of cattle each. Improved seed was supplied to them free of cost at the time of sowing and an equal quantity was recovered at the time of harvest. In the Salem district, side by side with prohibition, rural development was taken in hand. Five rural uplift schools were organized by the Collector and the agricultural officers. The Assistant Director, Tirupathur, took a few classes and impressed on them the possibilities of agricultural improvements. The Fruit Growers' Association at Vizagapatam conducted a fruit show and the marketing of sapota fruits was carried on by the Fruit Growers' Association at Pithapuram.

In BOMBAY, the gun club movement is becoming increasingly popular. In spite of the revulsion to taking animal life, the peasants of Gujarat carried out a successful campaign against *nilgai*. During the year, 1,294 wild pigs and 526 *nilgais* were killed by the *shikar* organizations in the province. New gun clubs were started in the East Khandesh district and the Southern Division.

In BENGAL, due largely to want of funds, most of the agricultural associations could not make much progress. In the Northern Circle the Cooperative Agricultural Association at Naogaon (Rajshahi district) maintained a farm and raised crops. In the Western Circle the District Agricultural Association of Howrah supplied seeds worth Rs. 412 to the cultivators in collaboration with the department. The District Agricultural Association, Birbhum, distributed 40 mds. of paddy seeds, 25 mds. of Sabour gram and 2 mds. of Pusa wheat. The District Agricultural Associations of Nadia and Bankura supplied 80 mds. and 15 mds. of Darjeeling potato seeds respectively.

In the PUNJAB, village farmers' associations are centres of concentrated departmental activity and receive the special attention of the staff. Other departments also find them valuable nuclei for developmental purposes. Members of these associations may include all, or they may consist of only a few of the cultivators of the villages in which they are formed. Any cultivator may become a member provided he agrees to carry out all the recommendations which the departmental staff may make with the object of improving his agricultural practice and procuring a better return from his holding. Since these associations are purely voluntary, local enthusiasm plays an important part in their success. The holdings of the village farmers' associations are practical demonstrations carried out in the course of everyday farming routine of what can be achieved by the application of scientific research. Many of them have achieved excellent results and several conduct simple agricultural experiments of their own under departmental guidance. Naturally the district staff gives priority of attention to the farmers' associations. They number 4,578 as against 3,482 during the previous year.

In the UNITED PROVINCES, there are over 2,000 agricultural associations. Of these two merit special attention. They are the Allahabad Agricultural Association and the Moss Agricultural and Village Improvement Association, Ltd., Ghazipur, both in the Eastern Circle. They are both registered associations and are actively engaged in agricultural propaganda in their districts. The Allahabad Agricultural Association maintains a plot of 17 acres on the *Magh Mela* grounds. The plot occupies a prominent situation and thousands of people visit it during festivals. It is run under the supervision of an

Agricultural Inspector. The Association receives a recurring grant of Rs. 1,000 for the award of prizes in cash or kind to the cultivators who compete at the annual exhibition. The Moss Agricultural Association maintains a school with a two years' course and a demonstration farm.

In the CENTRAL PROVINCES, the four associations in the Nimar district, held Verum cotton pooling work by providing a temporary staff of *jamadars* for roguing cotton and by advancing money to meet the contingent expenditure of the marketing work. There is an agricultural association in each tahsil of the Southern Circle. The Nagpur District Orange Growers' Association increased both share capital and membership. This association has been doing very good work and its operations during the year give hope of a bright future. The four registered tahsil agricultural associations in the Eastern Circle also work satisfactorily. With a view to encouraging cooperative marketing, growers' associations have been organized in all the three districts of the circle and godowns have been constructed at Raipur, Bilaspur and Drug for storing the produce. The cooperative central banks have agreed to advance to members three-fourths of the current value on the security of the stored produce at 4½ per cent interest. Cooperative dairies are also making good progress. In the Western Circle there are 23 taluka agricultural associations and 29 branch associations. All of them run shops for the supply of pure seeds, implements and spare parts.

In ASSAM, strenuous efforts were made to organize agricultural associations all over the province so that improvements which the cultivators could not effect individually could be achieved if they pooled their resources. The result was the formation of 133 associations through the initiative of the demonstration staff. The Livestock Improvement Association of Assam, with its branches, also continued to function.

In HYDERABAD, the village improvement associations of Patancheru continued to do useful work under the guidance of the Patancheru Centre. The objects were the improvement of the drainage and water supply, introduction of windows and ventilators in houses, organization of plague relief, social activities and educational dramas. The seed depots started the previous year worked satisfactorily.

In TRAVANCORE, the Department works through cooperative societies to introduce agricultural improvements. A few holdings belonging to cooperative societies have been selected for rural development work and grants were given to three cooperative societies for the maintenance of stud bulls. Four societies sell manures as commission agents of the Department. Agricultural officers attend the conferences of cooperative societies, deliver lectures and take active part in exhibitions organized by them. There are also cooperative dairies and fishermen's cooperative societies.

5. Seed multiplication and distribution

The multiplication and distribution of improved varieties of seed are the most important functions of the Agricultural Department, and great attention is given to it by the propaganda staff throughout the country.

For a considerable time the Indian Central Cotton Committee made grants exclusively for agricultural research, but in 1929 it was decided that the time

had come to support the efforts being made to bridge the gap between the experiment stations and the cultivator and to supplement the funds which the Agricultural Departments were devoting to the introduction of improvements into agricultural practice. Special attention has since been devoted to seed distribution schemes and to the more extended distribution of pure seed of improved varieties of cotton. During 1938-39 there were 17 seed distribution and extension schemes in operation in the cotton-growing provinces and states.

Another all-India organization interested in the distribution of improved seed is the Imperial Sugarcane Breeding Station, Coimbatore. As usual, seeds and seedlings were supplied from here to stations in sub-tropical India such as Karnal and Shahjahanpur. A short summary of the improved seed distribution work done in each province is given below.

MADRAS. Throughout the province there is an appreciable increase in the demand for improved seed. The total area under all improved strains of paddy, including the natural spread, is estimated at 1,704,399 acres. The total quantity of paddy seed distributed in the province through departmental agency was 8,247 tons.

The quantity of improved Cambodia cotton seed distributed was 276,089 lb. The total area covered by the improved strains in the whole province was 216,282 acres against 246,367 acres in the previous year, the decrease being mainly due to famine conditions in the Coimbatore district.

The Indian Central Cotton Committee financed the Tiruppur Cooperative Sales Society with a grant towards the pay of a demonstrator and a *maistry* for 1938-39. The Society, which has undertaken the work of distributing Co 2 (Cambodia) sown in the Tiruppur area, issued enough seed to cover an area of 5,679 acres for multiplication, but owing to an unfavourable season not more than 2,689 bags of good seed were obtained against 13,145 bags in the previous year. The area under Karunganni cotton is estimated at 162,971 acres, and 155,192 lb. of pure seed of the two recommended strains were distributed during the year. It is calculated that every acre under H 1 cotton in the Bellary, Anantapur and Cuddapah districts brings in an extra profit of 12 as. per acre in Bellary and Anantapur districts and Rs. 2-8 per acre in Cuddapah and Kurnool districts. The area sown to this cotton increased from 222,843 acres to 248,954 acres. Northerns cotton grown in the Nandyal tract, which increased in acreage from 4,368 to 10,160, sold at a premium of Rs. 24-8 per candy of 500 lb. over the local to Messrs Binny and Co.

The total number of sugarcane setts distributed in the province was 21,203,512. The total area under new varieties increased to 54,515 acres from 40,064 acres in the previous year. Different varieties gain popularity in different areas; Co 419 has given the highest yield and is likely to become popular in the Hospet taluka as well as in the Tirupattur division. In the Third Circle, however, the introduction of thin canes like Co 281, Co 213, Co 352 and Co 353 has given greater impetus to cane cultivation.

The total quantity of *jonna* seed distributed was 40,039 lb. as against 22,415 lb. during the previous year. The demand for improved varieties is on the increase because *jonna* is the most important staple food crop of the dry districts. *Ragi* is an important crop in the Vizagapatam district and is grown there during all the three seasons. The total area under improved strains in

the whole province was 19,816 acres against 7,532 acres during the previous year; and the total quantity of seed distributed was 24,954 lb. A total of 60,094 lb. of groundnut seed of all improved varieties was distributed during the year. The cultivation of Harrison's Special cigarette tobacco made headway in Guntur and parts of the Kistna and West Godavari districts where it covered 1 lakh acres during the year. Harrison's Special Nos. 8 and 9 remained popular and 300 lb. of seed of the two varieties were distributed to the ryots. The total area covered by the two strains was 7,788 acres. In South Kanara an enquiry was conducted into the alleged malpractices of mixing sand with tobacco leaf and vigorous propaganda was conducted among the growers and merchants against this practice. The Department supplied 16,052 seed coconuts and 4,497 seedlings to the public as against 14,676 and 4,306 respectively in the previous year. The demand is on the increase and is heing met from the coconut research stations as far as possihle. The quantity of potato seed sold by seed-farm ryots and the research stations amounted to 139,586 lb. The total area under superior varieties of potato on the Nilgiris increased to 14,592 acres and the extra profit to the cultivators is estimated at Rs. 3,21,024 per annum. The Department also supplied 32,288 mango grafts, 22,470 citrus (lime and orange) plants, 31,199 pineapple suckers and large quantities of other plants to the cultivators.

In BOMBAY, it was decided to entrust the work of seed distribution to the newly established Rural Development Department. Pure seed will be raised at Government farms and research stations. In 1938-39, however, the work of multiplication and distribution was done by the Agricultural Department. During the year there were five organized seed distribution schemes for improved varieties of cotton, centered at Surat, Broach, Dharwar, Jalgaon and Kopargaon, and the varieties were 1027 ALF, BD 8, Jayawant, Gadag No. 1, Jarila and Banilla respectively. The schemes continued to réceive financial assistance from the Indian Central Cotton Committee. The Surat scheme was extended to 11,736 acres and 2,273,633 lb. of seed were distributed through 24 depots. The prospects of 1027 ALF in Surat district have been improved by the amendment of the Cotton Transport Act of 1923 with a view to restricting the transport of *kapas* and cotton seed from Olpad taluka and part of Chorasi taluka into the Surat area. As a result of the Cotton Control Act, 1925, Goghari cotton has been completely eliminated, but its place has been taken to some extent by the inferior quality selection I. D. cotton. In the Broach and Panch Mahals districts the cultivators greatly appreciate BD 8 cotton which sold at a premium of Rs. 39 to 53 over current Broach quotations. In the Southern Maratha country, for which the Dharwar scheme has been designed, the cultivators obtained an extra premium of Rs. 3-10 for Jayawant and Rs. 9 for Gadag No. 1 over the ungraded local crops. The total pedigree seed of the 2nd to the 6th generations stocked for distribution in 1939-40 was 4,477,986 lb. of Jayawant and 1,066,865 lb. of Gadag No. 1. In the Jalgaon Jarila distribution scheme, 98,480 lb. of pure Jarila seed were distributed during the year, the total area covered was 4,980 acres; and the area of natural spread was about 5,000 acres. Over 500,000 lb. of Jarila cotton seed have been stocked for distribution in 1939-40. An attempt is also being made to extend tbe cultivation of 1027 ALF cotton in Nandurbar and Nawapur talukas of West Khandesh and 11,120 lb. of the seed were distributed. The

Banilla seed distribution at Kopargaon has not worked well and reorganization of the work is under consideration.

As regards other crops, the seed distribution will in future be handled by the Rural Development Department. In 1938-39 over 270,000 lb. of improved paddy varieties were distributed in the Southern Division. Also 608,000 setts of improved sugarcane varieties and 32,844 budded and grafted fruit trees were supplied. In Gujarat, 21,947 lb. of Budh Perio No. 53 *jowar* seed were distributed. In Ahmedabad district alone 32,580 lb. of sunn-hemp seed, 19,280 lb. of improved wheat seed, large quantities of *bajri* No. 207 and *magdi* and Spanish peanut were distributed. In Surat, 40,000 setts of POJ 2878 and Co 419 sugarcanes were distributed. In the Deccan Canals tract 1,294,200 setts of improved sugarcanes were supplied to irrigators.

In Bengal, a scheme for the introduction of long-staple cotton in six districts with the cooperation of the Bengal Millowners' Association is in progress, as there is a growing demand for this cotton in the mills of Bengal. Due partly to excessive rainfall and partly to lack of knowledge, the crop was not successful in most of the districts where a trial was arranged ; but very encouraging results were obtained in Midnapore where the soil and environment appear to be suited to this crop.

In the Punjab, there is a lively appreciation of the importance of seed distribution as a means of agricultural improvement, and the Government is willing to incur the financial loss involved in providing improved seed on a large scale. The budget allotment for 1939-40 is Rs. 12 lakhs. The magnitude of these operations and their growth may be seen from the following table. :—

——	*1932-33*	*1933-34*	*1934-35*	*1935-36*	*1936-37*	*1937-38*	*1938-39*
	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.	Mds.
Wheat .	25,375	88,150	101,200	145,000	220,500	278,000	248,500
Cotton .	21,764	32,750	54,900	64,700	71,700	88,900	91,100
Rice .	715	3,358	4,360	3,200	4,860	4,070	5,350
Gram .	1,060	4,700	7,050	10,200	15,900	29,700	4,070*

* Distribution of gram purposely curtailed pending issue of new blight-resistant variety.

Smaller quantities of improved seeds of barley, oats, *toria*, groundnuts and potatoes were also provided. The Department purchased 1,548 mds. of berseem seed chiefly from North-West Frontier Province and sold it in the Punjab. Improved seed is sold at rates very little above the current market rate for seed of ordinary quality. A small premium in the case of seed, such as wheat, which can be used for consumption, is necessary to ensure that it is used for sowing. There were 1,103 non-official seed agents. The Government incurred a loss of Rs. 1,51,372 on seed transactions during the year, but more than a million acres were brought under improved crops and the cost to the Government was about 2½ as. per acre.

In the UNITED PROVINCES, seed distribution is being pushed forward vigorously. During the year 57 new seed stores were opened in the Sarda Circle. The figures of seed distribution for this circle are interesting.

	1937-38	1938-39
	Mds.	Mds.
Kharif	17,741	18,842
Rabi	44,612	56,124
Sugarcane and others .	60,000	135,757
TOTAL .	122,353	210,723

The seed is sown mostly in blocks where it is kept pure and the produce purchased for further multiplication. In this way it has been possible to secure and store an average of 1,050 mds. per seed store of pure *rabi* seeds alone during the year, a total of 120,000 mds. for the circle. In the Western Circle 75 new seed stores were opened, making a total of 113. In the Eastern Circle 69 new stores were added during the year and the seed distribution amounted to 38,488 mds. as against 16,446 mds. during the previous year. In the North-eastern Circle 72 new seed stores were opened of which 20 have been transferred to the Cane Development Department as falling within their zones of activity. The demand was in excess of the supplies, though 891,487 mds. of improved seed was supplied as against 180,446 mds. during the previous year. The total area under improved crops in the circle is estimated at 437,479 acres. The Mahabir Jute Mills, Shajanwa, distributed 50 mds. of jute seed free of cost through the Department. In the Rohilkand-Kumaon Circle 69 new seed stores were started. In the Bundelkhand Circle 49 new seed stores were started.

In the CENTRAL PROVINCES, 2·62 lakhs of mds. of pure seed were distributed in the Northern Circle as compared with 2·66 lakhs during the previous year. The slight fall was due to the smaller quantity of cotton and groundnut seeds distribnted in Nimar and Hoshangabad districts. In the Southern Circle 101,084 mds. of improved seed, 1,386,975 whole canes and 27,662 fruit plants were distributed. In the Eastern Circle 1·9 lakhs mds. of seed and 1,312,788 whole canes were distributed from private seed farms and seed unions.

There were 288 seed unions with 6,067 members. In the Western Circle 59,982 mds. of improved seed were distributed.

Seed distribution in ASSAM may be seen from the following table :—

Name of seed	Quantity of seed sold	Quantity issued for demonstratic .	Total
Paddy . .	95,355 lb.	78,598 lb.	1,73,953 lb.
Potato . .	52,723 lb.	42,324 lb.	95,047 lb.
Vegetable . .	21,232 pkts. & 57 lb.	5,413 pkts. & 22 lb.	26,645 pkts. & 79 lb.
Sugarcane setts .	*Nil*	79,841 setts	79,841 setts

There are three seed distribution depôts at Sylhet, Jorhat and Gauhati.

In Orissa, it is hoped to raise sugarcane seeds and seedlings of all varieties locally for distribution. During the year 131 mds. of Patna paddy seeds were distributed free by the Department for demonstration on cultivators' lands. *To extend cotton cultivation 48 mds. of Co 2 cotton were supplied free of cost* to cultivators. Sixty mds. of *potal* root, 8,616 plantain suckers and 800 pineapple suckers were distributed free. There were 19,349 grafts made on Government farms of which 5,760 were sold. Coconut seedlings have been raised for distribution to the public at cost prices.

In Baroda, the organization for the expansion of 1027 ALF cotton distributed 719,000 lb. of seed through departmental seed depôts chiefly. There were 81,690 lb. of BD 8 seed also distributed. Pusa wheat seeds amounting to 105,900 lb. were distributed. The progress in seed distribution can be gauged from the fact that three years ago the State seed farms could not have supplied 10,000 lb. between them. In the Amreli district alone 3¼ lakhs of cane setts were distributed. The total quantity of different kinds of seed made available to the public in the course of the year was 9·7 lakhs lb. as against 4·6 lakhs in 1936-37. In addition there were 3·25 lakhs of sugarcane setts.

In Mysore, expansion of seed distribution may be judged from the following figures :—

Year	Budget allotment	Value of seeds and manures supplied
	Rs.	Rs.
1936-37 .	10,000	9,813
1937-38 .	20,000	17,336
1938-39 .	20,000	25,000

The allotment for seeds and manures during 1939-40 has been raised to Rs. 40,000. The amount of seed distributed is shown below :

——	1936-37	1937-38	1938-39
Ragi . . .	16,838 Srs.	21,368	55,274
Paddy . .	25,369 ,,	44,631	121,331
Cotton . .	13,090 lb.	73,259	194,024
Groundnut . .	9,543 Srs.	8,920	22,310
Plantain suckers .	*Nil*	3,550	17,745
Sugarcane setts .	914,000	222,000	1,922,140

In Travancore, improvement by selection and distribution of seed was continued. The Paddy Farm, Nagercoil sold 12,479 lb. of selected paddy

seeds. The Economic Botanist distributed 6,579 lb. of his strains of paddy seeds. The Sugarcane Farm, Alwaye, distributed 24,058 healthy sugarcane setts. Grafts, seedlings and seeds to the value of Rs. 625 were also sold from the Fruit Farm, Cape Comorin.

6. Implements

Steady progress was maintained in the introduction of improved agricultural implements during the year. In Appendix V will be found statistics of sales effected through departmental agencies. These figures do not, however, give a correct estimate of the total number of implements sold as private agencies and village blacksmiths also deal in implements on a large scale. Departmental sales therefore represent only a part of the material purchased by cultivators during the year.

Demonstrations of the working of improved agricultural implements were given in MADRAS as in previous years. Ridge ploughs and H. M. Guntakas were in greater demand in the Vuyyur sugarcane area and the Kifayat Rohat waterlift gained some popularity in citrus garden areas. Round about Guntur and Tenali, where cheap electricity is available, 15 wells were fitted with electric pumps in the place of the old bullock *mhotes*. There were 16,886 demonstrations of improved ploughs, and 4,339 iron ploughs were sold during the year as against 6,608 in the previous year.

In BOMBAY, the Agricultural Engineer dealt with 253 enquiries for technical advice and assistance. Thirty-four pumping sites were surveyed and 60 estimates for power plants were supplied to applicants. A private firm, viz. the Hubli Tractor Plough Co., nndertook tractor ploughing against *hariali*. Over 600 acres of cultivators' lands were ploughed in three months.

In BENGAL, 581 improved ploughs were distributed and an improved type of hand-hoe was also produced of which 350 are now in the districts. The hand-hoes are useful for inter-cultivation for such crops as winter vegetables.

In the PUNJAB, fodder cutters continued to occupy the premier place. Introductiou of this machine has given rise to improved industry. There was a fall in the number of Meston ploughs sold during the last three years and a rise in the sales of the heavier Hindustan type. Sowing drills are becoming popular, 2,192 being sold during the year, a figure three times as large as that for any recent year. It has been found that both single-row cotton drills and furrow turning ploughs of the Hindustan types are being manufactured in large numbers in several villages in the Lower Bari Doab and Nili Bar Canal colonies and sold at very low rates to local cultivators. In some villages also cheap bar harrows, hoes and Ravi automatic drills are being copied very successfully by local artisans. This is a step forward. It is hoped that with the completion and patenting of the design of the new cultivators which won the Punjab Government prize of Rs. 3,000, manufacture of these implements on a mass-scale will be arranged. Their cheapness and practical utility are expected to appeal to the cultivators.

In the UNITED PROVINCES, there was a considerable expansion in the sale of implements. In the Rohilkand and Kumaon Circle, 13,159 implements were sold in 1938-39 as against 3,590 during the previous year. In the Bundelkhand Circle the value of implements sold in 1938-39 was Rs. 30,443 as against

Rs. 4,351 during the previous year. The implements were mostly Gurjar and Kirloskar ploughs, Akola hoes, chaff-cutters and Sultan Mills.

In the Central Provinces, improved implements worth Rs. 38,418 were sold in the Northern Circle as against Rs. 35,210 in the previous year. The sales included 344 ploughs, 32 sugarcane mills, 31 winnowers and 29 water-lifts. *Taccavi* loans amounting to Rs. 17,441 were granted for the purchase of improved implements, seeds and manures. In the Western Circle the implements most in demand is the iron plough of which 509 were sold as against 621 in the previous year. The falling off in demand is due to unsatisfactory economic conditions. Demonstrations were given with a small bullock-driven No. 10 chaff-cutter in the Ashram at Shegaon. Kirloskar centrifugal sugarcane pumps were worked at the exhibition at the Malguzars' Conference at Nagpur. A gas engine running on charcoal gas and a suction gas producer were demonstrated at Tripuri.

In Assam, demonstrations with Meston ploughs, hand-hoes, power-driven irrigation pumps, sugarcane crushers, *gur* boiling pans, McGlashan furnaces, etc. were carried out successfully.

In Hyderabad, agencies in various districts have been opened by the manufacturers of agricultural implements and an iron works has been established in Hyderabad. Blacksmiths and villagers are copying some improved implements and supplying them direct to the cultivators. Excluding such implements, the Department supplied 194 implements and 1,625 spare parts. The sale of spare parts suggests that the implements bought in previous years are still in use. Advice is also given by the Department regarding the selection and erection of power-pumping plants.

In Mysore, there was a considerahle expansion in the demonstrations of improved implements. In 1938-39 there were 5,043 demonstrations as compared with 2,931 during the previous year.

In Baroda, there was, in general, an increase in the efficiency in the demonstration of agricultural implements. The implement in greatest demand was the Baroda cultivator and hoe designed in the State. The introduction of the hire-purchase scheme during 1939-40 is expected to improve the sales of implements. It is felt that a larger sale of implements would take place if the implements could be provided at the time the cultivators were impressed by field demonstrations. At present some time elapses between the demonstrations and booking of an order and supplies, leading to refusal. This will probably be met by adding to each itenerant unit a cart carrying implements for immediate disposal. Among hand implements the chief tool is the cotton root-puller which was intensively advocated as a means to reduce the damage by the spotted bollworm on cotton. Six wheat threshing implements being modifications of an implement of the type based on the old Olpad thresher and designed in the United Provinces were put out for demonstration.

In Travancore, while there is caution in the matter of introducing improved agricultural implements and machinery, light iron ploughs like the Climax and the Meston which suit the conditions of the State were introduced. The local blacksmiths make and sell iron ploughs in imitation of these. The ryots' scepticism about the ability of the local bullocks to draw the iron plough is fast disappearing. Agricultural officers demonstrated the working of these ploughs on the ryots' own lands with the latter's cattle. As fragmentation of

holdings is proceeding apace, the introduction of big machines like the tractor is out of the question. The Chattanooga Iron Mill installed in the sugarcane farm at Alwaye is a cheap and efficient machine. It expresses 70 per cent of the juice. Several demonstrations of this machine were held during the year for the benefit of the cultivators.

7. Fertilizers

Appendix VI gives statistics showing the sale of fertilizers through departmental agencies in India. A short account of the use and sale of various fertilizers is given below.

In MADRAS, artificial manures are stocked and sold by commercial firms and the ryots are directed to them for their supplies. The Department offers advice on the proper use of fertilizers in combination with organic manures and large quantities of these manures are being used for sugarcane and potato crops. Better methods of preserving farmyard manure continued to be an improved item of propaganda. There were 34,168 manure pits; 34,105 dry earth sheds and 65 loose boxes under the direct supervision of the provincial demonstrators. Composting of night-soil with municipal rubbish was demonstrated in some areas. Municipalities and *panchayat* boards are taking gradually to the manufacture of composts. Utilization of all habitation wastes, cane trash, groundnut husk and other organic wastes and the Bangalore method of preserving manure are being advocated and adopted. The total number of compost pits during the year was 5,352 as against 3,063 in the previous year. To supplement bulky organic manures the ryots are advised to grow green manure crops like *dhaincha*, indigo, sunn-hemp, *vempali* and *pillipesara*. Demonstrations were also given to the improvement of green manure when applied in conjunction with phosphatic manures. The area nnder green manure crops is steadily increasing. The total quantity of green manure seed supplied to the cultivators was 346 tons which served an area of 288,184 acres.

In BOMBAY, efforts to educate the people to increase the supply of bulky organic manures were continued. In particular, attention was paid to the storage of farmyard manure, and new manure pits were dug. In the Dhulia section alone there were 2,405 such manure pits dug during the year. Composting was encouraged through the activities of a special staff. In East Khandesh, West Khandesh and Nasik 10,850 lb., 14,441 lb. and 43,190 lb. of sunn seed was distributed. Demonstrations were also given of the manufacture and use of bone manure. Sulphate of ammonia is the most widely sold fertilizer for irrigated crops, especially for sugarcane. Groundnut and castor cake are also common. The distribution of this fertilizer is done chiefly by the Taluka Development Associations.

In BENGAL, making of artificial farmyard manure is regarded as an important demonstration in rural areas. Apart from using all sorts of vegetable waste products the possibilities of using water hyacinth—an easily available and valuable ingredient for compost making—were practically demonstrated to cultivators. The total quantity of manure manufactured from all sorts of waste products, including water hyacinth, amounted to 56,087 mds.

In the UNITED PROVINCES, demonstrations are regularly given of green manuring, manure pits and compost making. In the Western Circle, for example, the distribution of fertilizers and manures has gone up from 20,647

mds. in 1936-37 to 46,704 mds. in 1938-39. In the North-eastern Circle the increase was even more marked. From 12,199 mds. of manure in 1937-38 the distribution rose to 62,799 mds. in 1938-39. The advance would have been greater but for floods, frost and hail, which upset the agriculturist of this area.

The demand for fertilizers is also increasing in the CENTRAL PROVINCES. In the Southern Circle, for example, 8,684 mds. of fertilizers were sold as against 6,198 mds. during the previous year. *Taccavi* loans amounting to Rs. 16,607 were given for the purchase of improved manures, etc. In ASSAM, demonstrations were given of oil-cake, bone-meal, Niciphos, Ammophos, ammonium sulphate, sodium nitrate and other manures. At the same time demonstrations were given of the preservation of cowdung, composting, etc. During the year 763 manure pits were dug as against 580 pits in the previous year. Green manuring was also a subject of demonstration. In ORISSA, 847 composting heaps were made on cultivators' lands through the Agricultural Overseers in charge of propaganda.

HYDERABAD cultivators are now using increasing quantities of oilcake for manuring their crops. The Department is recommending castor cake as it is non-edible but some cultivators prefer groundnut cake when it can be had cheaper. Imperial Chemical Industries have opened agencies in many parts of the State. Artificial fertilizers and other manures were sold through departmental agency for an area of 3,769 acres. This does not include the large quantity sold by the fertilizer firms direct to the cultivators.

In BARODA, there has been a marked increase in the issue of bone-meal and sunn seed, particularly in the Baroda district. There was also a demand for the special cake and fertilizer mixture from sugarcane growers in Gandevi as the result of demonstrations. Special credit terms were devised for this mixture and 30,164 lb. were issued.

There is a feeling among TRAVANCORE cultivators that they lack manures. In the absence of a general practice of composting the state of affairs can be remedied only by artificial manures to supplement the limited quantity of manures available. The leading foreign firms selling fertilizers in Travancore are Imperial Chemical Industries, Messrs .Stanes and Co. and Messrs Parry & Co. During the year the value of manures sold by the second and third firms amounted to Rs. 35,589. In addition, a local firm sold manures worth Rs. 3,000. Four cooperative societies which were the departmental agents for the sale of manures effected sales to the value of Rs. 400. The municipalities of Quilon, Nagercoil and Trivandrum prepared and sold night-soil compost on a large scale.

8. Animal husbandry

More attention is being paid to the necessity for propaganda for the improvement of cattle in all provinces and states and it is proposed in this review to discuss at some length the work being done. In many places there is considerable apathy on the part of the cultivators and to some extent a degree of resistance to the improvements advocated is met with. It is not, however, unusual for propaganda staff of all kinds to experience difficulties in inducing the cultivators to adopt new methods in place of the old.

There are two classes of district work: (*a*) work done by the veterinary staff on tour in treating cases, visiting areas of epidemics, performing inocula tions against diseases, castrations, etc. and (*b*) propaganda by means of shows and fairs, lectures and distribution of pamphlets. Work done under category (*a*) is summarized in Appendix X.

Nothing can indicate the scale of the provision against cattle disease than the number of hospitals and the cases treated there as well as outside. The following comparative statement for the past three years is worthy of note :—

—	1935-36	1936-37	1937-38
Number of hospitals and dispensaries	1,086	1,111	1,138
Number of cases treated at hospitals and dispensaries.	3,476,739	3,873,968	4,052,200
Number of cases treated on tour	2,283,127	2,189,425	2,504,917

The leading propaganda activities are cattle fairs and shows at which prizes and *sanads* are awarded, lectures given on common diseases and their control, hygiene, breeding, first-aid, etc. and breeding bulls distributed. All these activities promote better knowledge of animal husbandry and, especially where shows and exhibitions are concerned, bring about improvements in the cattle by encouraging the spirit of rivalry among cattle breeders.

In MADRAS, the veterinary staff attended cattle shows at Annamalai, Tiruppur and Anchetti where they delivered lectures on breeding and feeding of cattle. It is believed that if the present work is continued uninterrupted the Annamalai areas will become a good breeding place for milch cattle. The Department took part in agricultural and *khadi* exhibitions where demonstrations were given of milk separation, milk testing and butter-making under modern conditions. A loan of Rs. 16,800 was given to a private dairy farm in Tinnevelly district for extensions. To save city dry cows from slaughter, and to encourage the return of the cows to their breeding areas railway rates have been reduced. Cattle owners take advantage of the reduced rates and send more cows back for maintenance while dry. The milk and breeding bull schemes of the Coimbatore District Board made good progress and the Tanjore District Board is expanding its activities in cattle breeding.

In BOMBAY, there were 40 cattle shows held in the year as against 27 in the previous year. The show idea is popular: 2,148 animals competed for prizes against 1,126 in the previous year. The prize money was Rs. 2,434 as against 1,334. Side by side with the extension of the gift bull scheme, work is being done to extend and improve grasslands, grazing areas and fodder production. On 1 July 1939, 278 premium bulls were stationed at different centres as compared with 193 on 1 July 1938. During the year 270 pedigree cockerels were distributed in various districts and 90 villages have been chosen for concentrated poultry improvement work. Silage-making demonstrations were frequently given and the cultivators advised on the introduction of improved fodder crops.

In BENGAL, there were five horse shows and 61 cattle fairs and shows during the year 1938-39. The departmental staff attended these fairs, opened

temporary dispensaries and gave lectures and demonstrations on veterinary matters with the help of models, posters and magic lantern slides. The cultivators gather in large numbers on such occasions and watch everything going on with much interest. The lack of adequate propaganda staff is, however, felt.

Over a thousand breeding bulls were issued on payment in the UNITED PROVINCES during the year. Government have sanctioned a special grant of Rs. 70,000 for the purchase of bulls in addition to the annual grant of Rs. 50,000. The work being done is greatly appreciated by cattle breeders and the demand for breeding bulls exceeds the supply. There were 35 important cattle and horse fairs, shows and exhibitions which were attended by the staff. To encourage the horse-breeding industry one-day horse shows were organized in several areas, and prizes were given for good brood-mares and the breeding of Government stallions. A veterinary stall was erected at the Swadeshi Exhibition at Lucknow opened by the President of the Indian National Congress and at the Health Exhibition organized by the Anti-Tuberculosis League.

In the PUNJAB, there were 280 fairs which were used for propaganda purposes. There were also 61 one-day village cattle shows. The Department selected and exhibited over 240 animals of various classes at the All-India Cattle Show and won a large number of cups and cash prizes including the Viceroy's Challenge Cup for the best animal in the show which was won by a Murrah buffalo of the Rohtak district. There is an awakening in the Punjab among cattle breeders in regard to the control of contagious diseases and improvement of animal husbandry. A number of useful bulletins in this connection were also published by the Department.

In the CENTRAL PROVINCES, there were 14 cattle fairs and shows attended by veterinary assistant surgeons who lectured to visitors on live-stock improvement, control of contagious diseases and veteriuary hygiene in general. Veterinary stalls were also arranged at the All-India Industrial Exhibition in connection with the Indian National Congress at Tripuri. Propaganda was also done at rallies organized by the Cooperative Department. The distribution of breeding bulls and cockerels, among other activities, made good progress during the year in spite of the fact that, in the absence of specialized propaganda staff, the work has to be attended to by the district staff in addition to their other duties. Though enthusiasm was difficult to arouse, especially with regard to breeding bulls, the situation is regarded as hopeful, especially as a result of constant propaganda. During the fairs, shows, conferences and other meetings of the rural population lectures and demonstrations were given on cattle breeding, silage making, dairying and poultry farming.

In ASSAM, there were six fairs or shows as opposed to 10 during the previous year. The Veterinary Department, wherever possible, opened stalls and exhibited specimens, models, charts, diagrams, etc., distributed leaflets and gave lectures on cattle welfare and contagious diseases.

In the NORTH-WEST FRONTIER PROVINCE, the annual horse show and cattle fairs were held at Haripur and in the Malakand agency. One-day cattle fairs were held in several other districts and demonstration stalls were arranged by the Department. Public interest in these shows was satisfactory and strict precautions were taken to avoid the introduction of contagious diseases at fairs.

In ORISSA, there were 13 cattle shows under the auspices of the Utkal Go-mangal Samiti and two animal welfare shows in Cuttack and Berhampur by the S. P. C. A. in addition to the usual demonstrations in making silage and compost and preserving manure. Model cowsheds were exhibited. The number of exhibits showed an increase. Prizes awarded amounted to Rs. 2,045 as against Rs. 659 the previous year. The Department gave a grant of Rs. 1,500 to the Utkal Go-mangal Samiti as usual.

In SIND, there were 16 cattle fairs and shows and also a horse show at Jacobabad. In BALUCHISTAN tbere was an increase in the entries of cattle at fairs and shows. In AJMER-MERWARA and COORG a similar increase was observed.

In MYSORE, the departmental staff and divisional officers attend cattle fairs and shows as well as the district, taluk and village *panchayat* conferences where, by means of informal talks and lectures on cattle disease, they spread the knowledge of veterinary aid. Similarly, health and baby weeks are made use of for the display of posters and exhibition of pathological specimens. Visual demonstrations for the benefit of illiterate people have proved very popular and it is proposed to purchase a motor van for the purpose.

In BARODA, efforts were made at the Kosamba centre to extend the poultry industry. The villagers were given 1,193 hatching eggs on a half share basis in some cases and in others at a nominal price of 12 as. per dozen. There were 51 breeding cocks introduced in the centre villages. Selected villagers were given training in modern poultry farming and established with the help of a grant-in-aid of Rs. 200 as poultry farmers in their villages. This training scheme, which is being financed by the Diamond Jubilee Trust Funds, is being continued.

CHAPTER XII

AGRICULTURAL EDUCATION

1. Agricultural colleges

REPORTS from different provinces indicate that a larger number of candidates are now being attracted to an agricultural career. This has been markedly evident in the United Provinces and the Punjab where the number of students seeking agricultural training beats all previous records. An increase of admission is also shown in the Coimbatore and Nagpur colleges. School education is becoming popular in certain centres, particularly the United Provinces and the Central Provinces, and a demand for short term practical courses is definitely on the increase in all provinces. In the Punjab a special feature of this education is the increase in the number of lady candidates. The Agricultural Departments are trying to cope with these demands as far as practicable.

MADRAS. During 1938, 187 applications were received for admission to the Agricultural College as against 184 in the previous year. Out of these 31 candidates joined the college and 10 seats were filled from the waiting list. Two students from Orissa and one from Coorg were also admitted. With the re-admission of three failed students, the final strength of Class I stood at 47. During 1939, 232 applications were received and 37 candidates were selected for admission. Two students from Hyderabad were also admitted. The final strength stood at 50 including one failed student who was readmitted. Thirty-eight candidates appeared in the final examination in 1938 and 26 passed, while in 1939 out of 35 candidates 29 passed. The teaching sections were reamalgamated with research sections and heads of research sections are now made responsible for teaching in their respective subjects. Arrangements were made from this year to afford better training to students in curd and ghee making by increasing the number of hours in dairy practice.

BOMBAY. During the year, steps were taken to intensify the practical training in agriculture given to students in the new B.Sc. (Agr.) course. A scheme to extend the period of the terms of the college by six weeks has been accepted by the Bombay University. The revised syllabus will come into force from the academic year 1940-41. The additional time thus made available will be devoted mainly to practical training in agriculture. In addition, the teaching courses have been readjusted with the object of increasing still further the facilities and time for practical instruction in agriculture, including animal husbandry and dairying. A Forest Rangers' course of two years' duration has been carried on at the college since June 1938. The course was attended dnring the year by eight students, six of whom were selected by the Bombay Government and two deputed from the Indian States of Sawantwadi and Janjira.

BENGAL. The establishment of the Bengal Agricultural Institute at Dacca is making good progress. A sum of Rs. 1,50,000 was provided in the budget for 1938-39 for the construction of buildings, etc., and a further amount of

Rs. 2,00,000 has also been provided in the budget for 1939-40 for the same purpose. The construction of the buildings has been taken in hand and it is hoped to start the Institute at an early date. The construction of a dairy at Dacca to be attached to the institute has been completed. In view of the great need for well-trained Livestock and Assistant Livestock Officers for cattle improvement it has been arranged to train the Assistant Livestock Officers in the newly completed dairy till the Institute begins to function. Accordingly 11 Assistant Livestock Officers were under training since 4 March 1939. The Animal Husbandry course of the Bengal Agricultural Institute in collaboration with the Agricultural course will be started as soon as construction is completed.

There were 18 students on the rolls of the Basanta Kumar Agricultural Institute, Rajshahi on 31 March 1939 against 22 and 17 in 1938 and 1937 respectively. Out of these, five students appeared at the final examination in March 1939. Four were successful. Equipment of the farm in the Daulatpur Agricultural Institute, Khulna was purchased. A capital grant of Rs. 25,608 was received from Government for the purchase of implements, livestock, etc. The dairy was started in September 1938. An attempt was made to run the dairy on commercial lines and by the end of the year 28,000 lb. of milk was obtained. There were 29 students on the roll. Owing to the lack of equipment the first batch of students could not get satisfactory training and it was decided to extend the period of their training by six months.

UNITED PROVINCES. The number of students on the roll of the Agricultural College, Cawnpore, increased and accommodation both in the hostels and in the main buildings was added to. The demand for admission has risen, largely as the result of the many recent appointments made in the Department following Government's general policy of agricultural development. The number of students who applied for admission during 1938 was 338 as compared to 167 during 1937. Arrangements were made during the year to admit double the number of students in the first year class which now consists of 87 students. The Bihar Government sent 10 candidates to the college reciprocating for 20 United Provinces' students sent to the Bihar Veterinary College. Special instruction was given to the students of the first and fourth year classes in the manufacture of *gur*. The silkworm rearing industry received assistance from the Zoological laboratory in the College from where thousands of *eri* and mulberry silkworms were distributed. The Agra Province Zemindars' Association and other similar associations and district boards awarded scholarships to 24 students. At the ALLAHABAD AGRICULTURAL INSTITUTE there were 138 students during the year. The Institute had also ten girls in the newly started Home-making course and 25 young men under training in Farm Mechanics. The Science departments have increased greatly during the year in efficiency and in the amount of equipment, so that it has been possible to increase the number of students in each of the Degree Classes to 28. The Institute cooperated with the Government during the year in the training of a group of about 55 men who are working in the rural development centres of the United Provinces. At the end of the year the Engineering Department of the Institute was promised a subsidy by the provincial Government for the manufacture of agricultural implements which can be used by local farmers.

PUNJAB. The Punjab Agricultural College has never been so popular. Its laboratories and hostels were crowded to capacity and if accommodation

existed, it could be filled over again from the list of disappointed applicants for admission. During the year the record number of 708 students attended the various courses held at the college. Of that number 312 were taking the full four years' course for the Bachelor's Degree; 104 the one-year vernacular course in general agriculture; 32 the one-year course for teachers of rural science in middle vernacular schools and 30 the 12 months' course for fruit garden *malis*. There were 380 applications for admission to the first year of the Degree course against 290 last year. The standard of education of the applicants was most satisfactory and more than half had matriculated in the first division. The students who sat for the examination at the end of each of the four years of the Degree course were 90, 78, 76 and 61. Of these numbers 77, 74, 60 and 77 per cent respectively passed the examination at the first attempt. The demand for the two years' course is now very small and it is proposed to discontinue it.

CENTRAL PROVINCES. The special feature of the year was the inauguration, early in April, of the Vidya Mandir scheme drawn up by the Hon'ble the Prime Minister when in charge of the Education portfolio. The Agriculture Department was entrusted with the onerous task of examining all offers of land made in connection with the scheme with a view to determining whether they were capable of yielding an income sufficient to support the Vidya Mandir teacher. Three hundred and ninety-eight offers were examined by the staff, out of which 98 were recommended by the Department for final acceptance. The demand for admission to the Agricultural college was again very keen. Applications received were 132; 56 candidates were called for interview and 54 were admitted. The total strength at the end of the session was 170. For the Degree examination 31 candidates appeared, of whom 22 were successful. Of these, 9 were placed in the second division and 5 in the third, 8 passed without securing a division and one was given a compartmental pass.

The designation of the B.Ag. and M.Ag. degrees has been changed to B.Sc. (Agri.) and M. Sc. (Agri.) This will apply to degrees secured in the examinations of March, 1938 and thereafter.

2. Post-graduate training in agriculture

THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, NEW DELHI. There were 59 candidates for admission to the post-graduate courses beginning in November 1938, of whom 40 were recommended by the provincial authorities. Nineteen applicants were selected for admission: 6 in botany, 4 in agricultural chemistry, 3 in entomology, one in mycology and five in general agriculture. Of these, one in entomology left the course on getting an appointment. Nine students completed the course during the year and were awarded the Institute Diploma: three in botany, four in agricultural chemistry, one in entomology and one in mycology. The one-year course in Farm Organization and General Farm Engineering was completed by five students.

Admissions for post-graduate training at this Institute were in the past from 1 November every year, but experience has shown that 1 October is a more suitable date for the beginning of a new session as it represents the start of the *rabi* season and is thus important from the point of view of agricultural training. The Council of the Institute has therefore decided, after consulting

the Directors of Agriculture in provinces and states, to change the date of admission to 1 October from 1939.

Besides the regular postgraduate courses, facilities were given to nine students deputed by provinces and universities for short courses in special subjects: two in sugarcane and soil analysis, one in cytological technique at the Sugarcane Breeding Station, Coimbatore, one in plant-breeding, one in plant pathological technique, one in principles of applied entomology, and three in milking and handling of cows and calf-rearing. Seven postgraduate students and 22 I. D. D. students of the Imperial Dairy Institute, Bangalore, were given facilities to study the methods of cattle-breeding and mixed farming at the Agricultural Sub-station, Karnal. The postgraduate students spent a short period at the Imperial Agricultural Research Institute, New Delhi, as well. A few officers of the *Gur* Development scheme of the United Provinces were given facilities to study the process of the manufacture of active carbon and its application in *gur* and sugar manufacture.

CENTRAL PROVINCES. At the Agricultural College, Nagpur, two students continued their postgraduate work under the guidance and supervision of the Agricultural Chemist.

3. Agricultural schools

MADRAS. In Madras the school at Usilampatti was closed in April 1938 and was amalgamated with the local high school. The three schools at Anakapalle, Palur and Coimbatore continued to function. At Anakapalle there were on the rolls 24 boys during the year which was the same as in the last year, and 34 adult labourers in the night school. At Palur, the average strength of the school increased to 44 against 34 in the previous year. At Coimbatore there were 10 boys in receipt of wages and 18 boys without wages as against 1 and 19 respectively during the previous year.

BOMBAY. The Marathi Agricultural School at Dhulia and the Kannada Agricultural School at Devihosur remained under the control of the Agricultural Department during the year. The work done at these schools continued to be satisfactory. The Marathi Agricultural School, Dhulia, has now completed its 16th year and the number of students on the roll during the year was 33. For admission in the first year, 83 applications were received of which 19 were selected. The Kannada Agricultural School, Devihosur, was attended by 28 students during the year, mostly from Dharwar and Bijapur districts. Two hundred and eighty-seven boys have now been trained at this school.

BENGAL. In the Dacca Secondary School, 22 matriculated students and 3 teachers were admitted for training in January 1939. The total number of students in the two classes was 51 including 6 teachers under training. Twenty-three students sat for the final examination of whom 22 passed.

UNITED PROVINCES. At the Agricultural School at Bulandshahr the number of applications during 1938-39 was 150 as compared to 100 during the previous year. The examination results were very satisfactory. There were no failures and 9 out of 34 diplomats passed in the first division. Funds were provided during the year for expansion to a capacity for 80 boys to the Diploma class instead of 40. Four students from Ajmer and Alwar were admitted, and a special charge was made to the State concerned of Rs. 600 per annum per student for the Diploma course and Rs. 300 per student for short courses. At

the Agricultural School, Gorakhpur, the total number of applicants during 1938-39 was 518 as compared to 305 during the last year. Several educational tours were undertaken and the students were shown agricultural activities in the eastern and north-eastern districts. A demonstration in cooperation with the Cane Development Officer was given during the year in the manufacture of white *gur* with activated charcoal. This proved popular and a considerable demand in *gur* products was noticeable. The Governing Body of the School was constituted during the year and held its first meeting in March 1939. Arrangements have been made to admit 80 students instead of 40 to the first year class.

CENTRAL PROVINCES. There were in all 77 students on the rolls of the Robertson Anglo-Hindi Middle School, Powarkheda. Fourteen students appeared for the final examination of whom 13 passed. The Agricultural Anglo-Hindi Middle School, Betul Bazar, completed its third year under the control of the Department. It is gaining in popularity and the attendance is gradually increasing. Seventy-seven boys were on the roll at the end of the session as compared with 58 last year. Fourteen boys went up for the final examination and 12 passed. Instruction in carpentry and smithy work bas been provided for the ensuing year. The Peace Memorial Agricultural School at Buldana, which was opened in 1929, is still failing to attract the right type of boys. The main attraction is the stipend and the hope of obtaining Government service afterwards. Admission was formerly restricted to residents of Buldana district, but this rule was relaxed this year in favour of two boys from other districts. Out of 45 applicants, 14 were admitted of whom three left subsequently as they were not given stipends. Nine second-year boys appeared for the final examination and all passed. Eleven first year boys were promoted to the second-year class.

MYSORE. The total strength of the Hebbal Agricultural School at the end of the year was 49 as against 50 in the previous year. There were 27 scholarships as against 28 in the previous year. Out of 19 students who appeared for the Final Diploma Examination, 11 were declared successful. It is encouraging to note that the number of applicants for admission to the first year class has shown a slight increase as against the falling off in the two preceding years. The number of applications for admission in 1936-37 was 38; in 1937-38, 26; but in the year under report 44 applications were received for the first-year class and 19 were admitted. The question of revision of the course so as to effect a closer fusion between the crop and the animal husbandry section and to qualify the students for a Post-Secondary Diploma of the University is under consideration. The Vernacular Agricultural School at Ramakrishnapur made considerable progress during the year. The strength of the school rose to 19 in the first-year class. The course was extended from one to two years making second year's practical course obligatory in future, four students underwent the second year course voluntarily though the second-year course would he obligatory only from the current year. Thirteen out of 19 students who sat for the examination were successful.

The income of the school was doubled during the year. The students were given special training in cigarette tobacco work as they could be absorbed in the Mysore Tobacco Company. The addition of a tobacco barn and a poultry farm to the school is under consideration with a view to increasing its income and

giving more varied training. In the Sri Krishnarajendra Vyavasya Dharma Patasala, Chikkanahalli, 24 students were admitted during the year. Out of 23 students who sat for the examination 18 were successful. All the students were in receipt of scholarships of Rs. 7-8 per month. The question of enlarging the school farm is receiving attention. Poultry farming was added to the studies.

TRAVANCORE. Two Agricultural Schools, one at Koni and the other at Kottarakara, are being maintained by the Department on a temporary basis.

The total strength of the Agricultural School, Koni, was 29. Out of these 29 students and one private candidate who appeared for the Final Examination, 25 got through. Out of 78 applicants for admission, 30 were selected. One student left the school later and joined the State Forces. The strength of the Agricultural School, Kottarakara, at the end of the year under report was 22.

COCHIN. The Agricultural School could not be run this year also, as the Education Department could not depute its teachers for training. The private students who sought admission claimed some sort of help from the Government by way of stipend. It is hoped that the school will be run from the next educational year onwards.

The Horticultural School has now completed its 9th year. There are at present 18 pupils in the senior class and 19 in the junior class. These boys were given practical work during the morning hours and theory class in the evening. They have separate plots of their own for cultivation of various seasonal crops. A new batch of six students was taken to undergo a course of *mistry* training in all branches of agriculture for a period of one year. They were given ordinary wages during their course of training.

4. Rural 'bias' schools

BOMBAY. Agricultural bias classes are under the control of the Department of Public Instruction and only periodic inspections of the pupils are carried out by the technical staff of the Agricultural Department. This arrangement is being reviewed by the Director of Public Instruction but it appears to be essential that an adequately trained technical officer should be placed in general charge of the supervision of such classes if they are to fulfil satisfactorily the objects for which they were originally established.

BENGAL. The agricultural classes in the Moyna Peddie Memorial School (Midnapore) and Mathuran N. C. Institute (Burdwan) were discontinued for want of teachers and paucity of funds. Two other schools were recommended in their place. The grants to the Visva-Bharati University and Ushagram School at Asansol were discontinued. The Upper Primary Schools at Kishoreganj and Burirhat Farms were continued. In both these schools in addition to the general education required for the Upper Primary standard, the boys were given practical training on farms. Small plots were allotted to groups of boys for growing vegetables by themselves.

In Kishoreganj Farm School the roll strength was 49, and out of 4 boys sent up for the Upper Primary Examination three passed. In the Burirhat Tobacco Farm School seven boys were sent up for the Divisional Primary Final Examination and six passed.

UNITED PROVINCES. Numerous schools in the province teaching agriculture as an optional subject received advice and assistance from the staff of the Department who visited their schools and farms.

CENTRAL PROVINCES. Agriculture was taught as an optional subject in Basim and Betul Government High Schools. Agricultural instruction was also given in the middle schools at Itki Chandur Railway, Mowadih, Amarwara, Lakhnadon, Chhapara and Chaurai.

ASSAM. Gardening in schools, introduced with a view to imparting an agricultural bias to young boys, made satisfactory progress. During the year, 233 schools (128 in the Surma Valley, 71 in the Lower Assam Valley and 34 in the Upper Assam Valley) participated in this work compared to 238 schools (135 in the Surma Valley, 91 in the Lower Assam Valley and 12 in the Upper Assam Valley) of 1937-38.

TRAVANCORE. Summer schools were run at the Rural Reconstruction Centres of Marthandam, Collannoor and Warkala. During the year nnder report, the Departmental officers delivered magic lantern lectures, and gave talks to the students on rural topics.

5. Short courses

Short courses are gaining in popularity and are being organized in colleges, schools, farms and all places of experimentation where there is a demand for them.

MADRAS. Subjects on which short courses were conducted during the year at the Agricultural College, Coimbatore, were farm management, horticulture and vegetable gardening, insect pests and diseases, dairying, care of animals, beekeeping, *gur* makiug, farm implements and machinery and manures. The short course in agriculture was also continued during the year at the Agricultural Research Station, Nandyal. Eight applications were received, of which three were selected and only one candidate completed the course. In addition three pupil teachers of the S. P. G. Training School, Nandyal, were trained in both theoretical and practical agriculture at the Station.

Twenty-three students underwent training in fruit culture and nursery practices at the Fruit Research Station, Kodur. In addition 10 Upper Subordinates and 2 *mistries* were trained.

BOMBAY. During the year under report, special courses were organized in poultry-farming, horticulture, field-*bunding* and anti-erosion measures and in the management and care of oil-engines. The poultry-farming course was held under the Livestock Expert to Government at the Government Central Poultry Farm, Kirkee, and was attended by 57 students from practically all over the province. A similar course in horticulture, held at the Ganeshkhind Fruit Experiment Station, attracted 60 students. In addition, special district courses in these two subjects were organized at different centres of the province. As part of a widespread effort to increase the measures taken against soil erosion in the districts, an advanced course in *bunding* was held at the Agricultural College under the Professor of Agricultural Engineering. Forty-five students attended this course which aimed at providing those under instruction with sufficient training and experience to enable them to take part in the instruction of other cultivators in measures to be taken against soil erosion and to assist in

district training classes on this subject. A class in the erection, management and running of oil-engines was held, as usual, at the workshop of the Agricultural Engineer and was attended by 13 cultivator students. As in previous years, a Revenue Officers' Agricultural Course was held at the College for ten days in September and was attended by seven Assistant and Deputy Collectors deputed by the Revenue Department. Special courses in agriculture, plant pathology and chemistry were held and attended by six students.

BENGAL. In some of the Government farms sons of cultivators were given practical training, viz. Rajshahi Farm 2, Pabna 1, Dinajpur 2, Rangpur 2. In the Rangamati Farm three Chakma and two Mong youths received practical training during the year.

UNITED PROVINCES. Short courses in agriculture and allied subjects were held in agricultural schools and at Government farms throughout the province for training a large number of candidates deputed by the Rural Development Department, Cooperative Department and District Boards. In the Bulandshahr school, in addition to the Diploma Course, provision is made for a short course of six months to train candidates in farm mechanics and engine drivers; fieldmen and *kamdars*; teachers for rural schools; and cooperative marketing supervisors. The total number of candidates under training in these courses during the year was 226. Facilities also exist at the school for short courses in beekeeping, preservation of fruits, sheep and goat farming, and gardening. At the Agricultural School, Gorakhpur, not less than 94 students attended the short Fieldmen's Course.

PUNJAB. Short courses attracted considerable number of candidates during the year. Ninety were admitted to and passed through the short fruit and vegetable culture and preservation class; 35 in beekeeping courses; and 10 the dairy class. The short course for private estate managers drew 21 applicants and all were admitted. Fifteen village blacksmiths took the six weeks' course in the running of engines used for agricultural purposes and in the repair of implements. A feature of the education given at the Punjab Agricultural College nowadays is that some of the courses attract ladies. Twenty Sub-Inspectresses of the Cooperative Department and 31 private ladies took a special course in fruit and vegetable preservation. Recently as many as 40 private ladies applied for admission to a similar course and a special class was formed for them.

CENTRAL PROVINCES. The short practical dairy course provided in alternate years at the Agricultural College, Nagpur, was held from October to March and attended by ten students.

ASSAM. The Agricultural Training Classes at Sylhet and Jorhat, started during 1935, continued to function satisfactorily. These training classes have been started in accordance with the recommendation of the Assam Unemployment Enquiry Committee for training unemployed middle class youths for diverting them to agriculture. The course covers a period of 15 months and usually ten students in each class are granted a subsistence allowance of Rs. 6 per month. By the end of 1937-38, 45 students were trained in these classes and during the year 25 more boys, (10 at Sylhet and 15 at Jorhat) were admitted for training.

ORISSA. Forty-two students were given practical training at various farms in the province of which 30 were at the Cuttack Farm and the remaining at

Kujang, Khurda, Angul and Sambalpur. Three of these students were sent by the neighbouring Feudatory States. At the instance of the Director of Public Instruction, Orissa, six teachers from M. E. Schools of Cuttack, Balasore, Puri, Sambalpur, Ganjam and Koraput districts were deputed for undergoing training in agriculture at the Cuttack Farm. Training in fodder growing, silo-making, compost-making was given to Veterinary Assistant Surgeons at Cuttack and Sambalpur farms. Practical training in agriculture was also given to the stockmen of the Veterinary Department at Cuttack farm during the year.

Hyderabad. The Oil-engine Class was continued under the control of the Machinery Superintendent. Two classes were held during the year each of three months' duration. Eighteen students attended the class of whom 16 passed. This class has turned out 179 engine and pump drivers since its inception. A Gardener's Class was continued under the supervision of the Horticulturist. Its course lasts for two years. There were nine students on the roll during the year of whom two passed. Arrangement for a Farmer's class to train sons of cultivators in modern methods of agriculture for a period of two years was made at the Himayatsagar, Parbhani and Rudrur farms. The total number of candidates trained so far at these farms is 60.

At the Patancheru Centre which is primarily meant to train rural dvelopment workers, 35 teachers were trained in all aspects of rural improvement. In all 215 workers have so far been trained including the propagandists of the Hyderabad Cooperative Union and teachers of village schools. Two batches of Revenue Officers, who were deputed by the Revenue Department, were also initiated in the principles of rural development as practised at the Centre.

CHAPTER XIII

THE COOPERATIVE MOVEMENT AS AFFECTING AGRICULTURE*

SEASONAL conditions were unfavourable in parts of several provinces and states and the level of the prices of agricultural produce remained low throughout the country. In Madras, the north-east monsoon was a failure in the whole province and famine conditions prevailed in certain districts. In Bombay, the season was only slightly better than in the previous year. The monsoons were not evenly distributed and were particularly disappointing in north-Gujarat districts. Excessive rains in October did damage to the standing *kharif* crop in some districts. Large parts of the Punjab suffered from the deficiency of rain. In the Central Provinces and Berar the year was unfavourable to agriculturists like the previous year and the cotton crop suffered the most. Delhi Province had a similar story to tell and even Sind did not escape from trouble on account of adverse natural conditions. Orissa fared better but not so the North-West Frontier Province and Mysore. Thus agricultural conditions were more or less adverse in most parts of the country and this state of things combined with the prevailing economic depression to hamper the efforts being made in every province and state to rehabilitate the cooperative movement. The prevailing lower level of prices kept down the income of agriculturists and reduced their repaying capacity.

The work of rectification, revival and consolidation was resolutely carried on in respect of agricultural credit societies everywhere. Bad and hopeless societies were weeded out and care was taken not to register new primary societies unless they gave promise of successful working. Concession schemes were continued in most provinces and states. Remission or reduction of overdue interest and extension of repayment of loans over a series of years, were the remedies adopted and financing agencies were called upon to make the necessary sacrifices. Amounts of fresh loans given to societies therefore recorded a decline in several provinces. There was a tendency everywhere to concentrate energy on the improvement of existing societies and the work of expansion was held in check. The condition of central banks in Berar reached a crisis and efforts at a solution were being made. The position in Bihar was not satisfactory in respect of central banks and also the provincial banks. The position of provincial banks was generally satisfactory except in two provinces. Land mortgage banks also did fairly well.

A good deal of attention was paid to cooperative training and education. The importance of having trained secretaries and supervisors was universally recognized and classes were regularly conducted for the purpose. The training of Panchas has been regularly carried on and general propaganda has not been neglected. Schemes were formulated in some provinces for linking cooperation with rural reconstruction. Faith in cooperation as an effective

* The assistance of Prof. V. G. Kale, M.A., formerly Professor of History and Economics, Fergusson College, Poona, in the preparation of this chapter is gratefully acknowledged.

lever for village uplift remained undimmed in spite of adverse and discouraging economic conditions. Cooperative marketing of agricultural produce received considerable attention. Sale societies, particularly those concerned with cotton, cane, ghee, etc., made fairly good progress. The pace of cooperative development was, however, checked almost everywhere by the economic depression and the reduced earning capacity of agriculturists. Activities had to be directed mainly towards recovery and rehabilitation.

MADRAS. The year was one of general progress. The number of societies and their transactions increased, repayments recorded an improvement, and the movement expanded in new directions, especially on the non-credit and marketing sides. With the passing of the Madras Agriculturists' Relief Act and the introduction of prohibition in certain districts, a large number of people began to look to cooperative societies not only for finance but as a suitable agency for rural development work. The number of societies rose in consequence from 13,138 to 13,759 and their membership increased from 949,000 to 1,042,000. The transactions of the societies also recorded a marked rise. Primary societies advanced a larger number of loans to their members, and to meet their demand central banks in their turn resorted to borrowing from the Madras Provincial Cooperative Bank to a much larger extent than in previous years. The loans issued by agricultural societies, including land mortgage banks and sale societies, amounted to Rs. 307·79 lakhs, which exceeded the previous year's figure by about a crore of rupees and even topped the figures for 1929-30—the highest in recent years—by about Rs. 50 lakhs. The borrowings of central banks from the Madras Provincial Cooperative Bank increased from Rs. 32·79 lakhs to Rs. 64·88 lakhs.

In the sphere of mortgage credit, for discharge of prior debts, there was noticeable progress. Up to the beginning of the year, land mortgage banks had issned loans to the extent of Rs. 175·83 lakhs, and during the year Rs. 59·43 lakhs more were advanced. The loan applications which were pending disposal at the time when the Agriculturists' Relief Bill was published and those received later were not disposed of till the bill was passed into law. After the act came into force in 1938 the debts due to the creditors were in all cases scaled down according to the provisions of the Act, and only the sums so scaled down were paid to the creditors. (Rs. 41·01 lakhs due to the creditors according to the original contract were scaled down by Rs. 7·16 lakhs.) For financing the primary banks the Central Land Mortgage Bank issued during the year debentures for Rs. 39·57 lakhs and the Government, too, increased their guarantee of the debentures of the bank from Rs. 150 lakhs to Rs. 200 lakhs during the year and to Rs. 250 lakhs after the close of the year.

Alongside the expansion, central banks and unions pursued the policy of rectification and consolidation. During the year 746 societies were rectified by reducing the members' overdues in them to 40 per cent and less. The classification of credit societies according to their general working, however, revealed that though there was an increase in the number of good and fairly good societies, there was also an increase in 'D' class societies, that is, societies which would have to be liquidated if their working did not improve within two years.

The non-credit side of the movement received equal attention during the

year. The number of societies of all classes for purposes other than credit rose from 1,146 to 1,295. Sale societies have been established in all districts, and in some areas they have made marked progress. Some of the bigger sale societies are assisted by Marketing Inspectors recruited from agricultural graduates. There is an increasing appreciation of the advantages to the ryots in selling their produce through sale societies. Some of the sale societies are also linked with the Madras Provincial Marketing Society which finds a market for the produce sent to it for sale. The formation of milk supply societies and unions was an important item of the non-credit programme of the year.

Of the 828 societies registered during the year, 172 were for purposes other than credit. They include 41 weavers' societies, 17 sale societies, 15 milk supply societies and unions, 15 stores, 11 consolidation of holdings societies, 10 cottage industries and thrift societies for women and 4 labour contract societies. In pursuance of the policy of weeding out bad societies, the registration of 207 societies was cancelled during the year, as against 235 in 1937-38 and 195 in 1936-37. Dissolution was, however, resorted to after exhausting all methods of reformation or revival. There were at the close of the year 13,750 societies as against 13,138 at the beginning.

The increase in loan transactions during the year was largely contributed by loan and sale societies which gave loans to the extent of Rs. 95·86 lakhs as against Rs. 62·12 lakhs during 1937-38. The bulk of the loans continued to be for productive purposes, but compared with the previous year, there was a decrease in the percentage of such loans from 83·61 to 77·98. At the same time there was increase both in the amount and the percentage of loans issued by societies other than land mortgage banks for the discharge of prior debts: the amount rose from Rs. 26·26 lakhs in 1937-38 to Rs. 47·22 lakhs in 1938-39.

The bank granted loans to central banks to the extent of Rs. 64·88 lakhs during the year as against Rs. 32·79 lakhs in the previous year. The amount of loans issued was nearly twice that of the previous year. The increase was largely due to the encouragement of loans against pledge of produce, the amount lent for this purpose alone being about Rs. 40 lakhs as against Rs. 20·98 lakhs in the previous year. The loans outstanding against central banks at the end of the year were Rs. 56·93 lakhs of which Rs. 48·91 lakhs were short-term. A sum of Rs 34·79 lakhs represented loans against pledge of produce.

The year witnessed a large increase in the loan transactions of central banks generally. This was natural and expected. With the passing of the Agriculturists Relief Act, 1938, there was an increased demand for new loans as well as for new societies. Alongside the expansion the policy of rectification and consolidation of existing societies was pursued and 664 societies were revived during the year. The growing demands made on the banks were generally met, in some cases, with the help of the provincial bank, as a result of which the loans from the Provincial Bank to central banks considerably increased.

The Madras Provincial Cooperative Land Mortgage Bank had another year of satisfactory progress. It has been growing from strength to strength, and may well be proud of its solid achievements in the field of mortage credit within the short period of ten years of its existence. It has issued loans to the extent of Rs. 222·96 lakhs from the date of its inception up to 30th June 1939. Government increased their guarantee of the debentures of the bank from Rs. 150 lakhs to 200 lakhs during the year and to Rs. 250 lakhs after the close of the

year. The passing of the Agriculturists' Relief Act brought into greater prominence the need for a suitable agency to enable the ryots to discharge prior debts as scaled down according to the provisions of the Act. The business of the bank naturally went up, and the demand for financial accommodation by it is bound to increase.

At the beginning of the year, there were 101 primary cooperative land mortgage banks; during the year, 11 banks were registered, the total number of banks on 30th June 1939 being 112. Since the close of the year 8 more banks have been registered.

The year was one of all-round progress for loan and sale societies. Their number rose from 118 to 134 and their membership increased from 18,936 to 27,548. The marked rise noticed last year in their loan transactions was maintained during the year. From Rs. 26·16 lakhs in 1936-37 the loans issued by them rose to Rs. 62·12 lakhs in 1937-38 and Rs. 95·86 lakhs in 1938-39. On 30th June 1937 the loans outstanding against the members amounted to Rs. 56·53 lakhs.

The Madras Provincial Cooperative Marketing Society proved its usefulness during the year. It had 86 societies and 52 individuals as its members and a paid-up share capital of Rs. 6,100. It continued to receive from the government and the Madras Provincial Cooperative Bank the financial and other assistance which it has obtained in the past two years. It sold during the year goods worth Rs. 1·70 lakhs and earned a commission of Rs. 7,931.

Bombay. The number of agricultural credit societies, excluding land mortgage banks, was 3,704 as against 3,702 in the previous year. The membership decreased in the year from 195,719 to 192,759 and the working capital from Rs. 2,98,13,081 to Rs. 2,92,45,086. A policy of cautious expansion in the credit movement in rural areas was followed during the year. Fifty-six registration proposals were received. Four of them were refused as the Registrar was not satisfied about their soundness, and 54 new societies including 7 multi-purpose societies were registered. On the other hand, 45 societies were ordered to be wound up. The year thus records an increase of only 7 in the total number from 3,702 to 3,709 societies. Notwithstanding an increase in the number of societies, there was a decrease in the total working capital which is due to the all-round decrease in the bank loan outstanding, members' deposits and others ' outside liabilities ' including non-members' deposits. The decrease in members' deposits is partly due to their conversion into share capital in consequence of the adoption of share system by-laws by a number of societies and partly due to the set off of members' dues in the process of repayment. It is noteworthy, however, that the decrease in members' deposits is largely counterbalanced by the increase in their share capital. The decrease in the membership is due to the cancellation of societies, and also due to the process of weeding out undesirable members who very often act as a clog to the proper working of the societies. The reserve and other funds record a satisfactory increase, though it must be stated that certain facts have militated against the accumulation of bigger reserves. The concession scheme which has been in operation for a fairly long period has resulted in permanently lowering the rate of interests, leaving a comparatively narrow margin for profit. Secondly, amounts representing losses due to bad debts or non-recovery of interest are being written off against the reserve fund.

Fresh finance recorded a further decrease to the extent of over Rs. six lakhs as compared with the figures of the previous year. It may be pointed out in this connection that the figure has a direct relation with recoveries as the policy adopted at present is to allow fresh finance mostly for current agricultural needs to the extent of repayments, with a cut of 5 to 10 per cent when the outstanding loans are in excess of present needs or repaying capacity. A combination of several factors has thwarted the progress of recoveries which, though in several districts including the canal tracts of Poona and Ahmednagar record an increase over the previous years, do not show any appreciable improvement for the whole province.

During the year the process of classification of debts into frozen, bad and doubtful debts, which was introduced during the previous year as one of the measures calculated to clarify the financial positions of societies and central banks and to facilitate measures for rehabilitation, wherever necessary, was continued through the agency of supervisors, bank inspectors and auditors. These investigations were completed in 3,687 societies out of the total number of 3,709 societies.

It may be noted that the total of bad and doubtful debts in the societies investigated works out at 11·6 per cent of the total loans outstanding. The previous year's figures for doubtful and bad debts for 3,392 societies, wherein the classification of debts was completed were Rs. 19,76,485 and Rs. 11, 91,127 respectively as against 19,33,553 and Rs. 10,30,923 for 3,687 societies for the year under report. There is a distinct improvement in the position—particularly regarding bad debts—which can be considered satisfactory in the existing circumstances. On the basis of classification of debts, the usual measures designed to arrest deterioration in societies were put into force during the year.

Side by side with the process of classification of debts, the policy of granting concessions to borrowers of societies on collective as well as individual basis continued to be in operation throughout the year. The scale of concessions varied for different tracts according to the financial position of societies and the accumulation of overdue interest. In addition to these concessions, the societies were advised to amend their by-laws providing for a lower rate of interest in the case of members paying punctually.

In view of the impending debt relief legislation, instructions were issued during the year indicating the lines on which steps should be taken to reorganize credit machinery in rural areas. Past experience has shown that without linking up credit with marketing and encouragement of thrift, credit societies can do only limited good to agriculturists. It is necessary to organize an agency in villages which, while providing finance for current cultivation needs, would undertake also the marketing of agricultural produce. The organization of village multi-purpose societies on an extensive scale is, therefore, contemplated, and during the year instructions were issued to the departmental staff to take steps to organize one or two such multi-purpose societies in each taluka to start with.

The number of District Boards of Supervising Unions stands at 16. The staffs of the Boards of Supervising Unions consist of 6 senior supervisors, 106 supervisors and 19 assistant supervisors. The boards have been useful in exercising a certain amount of supervision and control over the working of the

unions. Like the unions, however, they too labour under financial difficulties and cannot perform their functions satisfactorily. The number of Supervising Unions including Guaranteeing Unions stands at 112. The number of societies affiliated to them was 3,505.

The number of land mortgage banks working in the province at the close of the year was 14. During the year Government sanction was received for the establishment of 9 more land mortgage banks of which one bank, viz the Gadag Cooperative Land Mortgage Bank in the Karnatak, was registered by the close of the year. There was a steady increase in the business of the land mortgage banks during the year although all did not show uniform progress. In summarising the activities of the land mortgage banks, distinction has been made between the three old land mortgage banks and the other banks established in recent years. Of the old banks, two have become involved in heavy arrears. In the case of the new banks all of them except one have had a smooth career.

During the year the number of members increased from 7,654 to 9,095. The amount of loans advanced to members has gone up from Rs. 13,60,470 to Rs. 20,90,748 which are exclusive of loans advanced by the Bombay Provincial Cooperative Bank prior to the establishment of the Bombay Provincial Cooperative Land Mortgage Bank and not yet taken over by the latter. The number of applications received by the primary land mortgage banks during the year were 990 and 632 applications were forwarded to the Provincial Land Mortgage Bank for the sanction of loans. The total amount outstanding with the members of the primary banks at the end of the year was Rs. 23,03,577. Out of the total loans advanced to the borrowers by the primary banks, Rs. 2,88,556 inclusive of interest were due for repayment. Rs. 74,377 in principal and Rs. 1,02,980 in interest were recovered during the period, leaving a balance of Rs. 1,11,299 to be recovered and amount overdue from members in all the banks is Rs. 88,997 including interest as against Rs. 60,658 at the end of the previous year. The overdues were especially heavy in the case of old banks.

During the year the Provincial Land Mortgage Bank received 702 loan applications for Rs. 11,52,089 recommended by primary banks, out of which 646 loan applications for Rs. 9,34,500 were sanctioned and 28 loan applications for Rs. 73,650 were rejected. The remaining applications were pending consideration at the end of the year. The bank received, since its inception, 2,174 loan applications for Rs. 37,58,052 out of which 1,807 loan applications for Rs. 25,54,050 were sanctioned after reducing the amount of loan applied for by Rs. 4,96,637. 114 loan applications for Rs. 3,56,825 were rejected so far and 145 loan applications for Rs. 1,65,050 were cancelled subsequently owing to failure of the applicants to comply with some of the conditions, on which loans were sanctioned. The total amount of loans advanced since the inception of the bank was Rs. 21,14,290 to 1,547 applicants recommended by 13 land mortgage banks. The minimum and the maximum limits for loans sanctioned by the bank to an individual are Rs. 400 and Rs. 10,000 respectively. The minimum limit in the case of the Kaira District Cooperative Land Mortgage Bank Ltd., Nadiad, has, however, been kept at Rs. 300 as a special case, no exception was made in the case of the maximum limit though applicatious from individuals asking for loans in excess of Rs. 10,000 each were received. Out of 1,547 loans for Rs. 21,14,290 advanced by the bank since its inception, 301 loans were for sums below Rs. 500, 611 loans for Rs. 4,84,265

were for sums between Rs. 500 to Rs. 1,000, 405 loans for Rs. 6,13,090 were for sums between Rs. 1,000 and Rs. 2,000, 194 loans for Rs. 6,17,580 were for sums between Rs. 2,000 and Rs. 5,000 and 36 loans for Rs. 2,65,000 were for sums between Rs. 5,000 and Rs. 10,000. The loans advanced by the bank were mainly for redemption of old debts and a very few loans were for improvement of lands and purchase of lands. Out of 1,547 loans advanced so far, only 6 loans for Rs. 9,800 were for purchase of lands, 17 loans for Rs. 20,800 were for improvement of lands, 38 loans for Rs. 51,200 were for joint purposes of redemption of debts and purchase and improvement of lands. The majority of loans granted were for amounts less than Rs. 2,000.

During the year the resources of the Provincial Cooperative Bank increased by Rs. 10 lakhs, from Rs. 173 lakhs to Rs. 183 lakhs. The bulk of the increase is due to the rise in deposits held by central banks and societies. The total amount invested by way of overdrafts, cash credits, loans and other advances declined from Rs. 98 lakhs to Rs. 90 lakhs. The decline is due to a reduction of Rs. 15 lakhs in ordinary loans, cash credits and overdrafts. Against this was an increase of Rs. 7 lakhs in advances against agricultural produce and loans outstanding from societies in liquidation. The position of the bank in respect of liquid resources is satisfactory.

Owing to the liquidation of the Kaira District Central Cooperative Bank Limited, which was ordered to be wound up at the beginning of the year, the number of Central Banks decreased from 12 to 11. The total working capital increased by a little over Rs. 4 lakhs and the central banks continued to have a plethora of funds. Out of the total working capital amounting to Rs. 2,99,34,387, Rs. 1,04,79,160 only are on loans with societies which clearly shows that the bulk of the agricultural credit societies for whose benefit the central banks are intended are not in a position to absorb the major portion of these funds. Plenty of surplus funds are, however, a source of strength as they enable banks to stand the strain, if any, due to change of circumstances. In order to utilize some of these funds to the mutual benefit of banks and affiliated societies, the necessity of the District Central Banks interesting themselves in the organization of supply of agricultural requisites and the sale of agricultural produce by organizing purchase and sale societies at suitable market places with a view to encourage crop loans and make advances in kind, was emphasized. It was also pointed out that, pending the organization of such supply and sale organizations, the banks themselves may undertake the work strictly on a commission basis.

The year under report was eventful both for the future of the cooperative movement and of rural development in this province. The question of how best the rural development work done by the Agricultural, Cooperative and other departments separately could be organized so as to avoid duplication of work and secure greater efficiency and more economical use of Government resources had been engaging the attention of Government for some time, and after consideration of the question, Government came to the conclusion that this object would best be achieved by placing all rural development and propaganda in the hands of one department with a sufficiently extensive and well equipped organization. Accordingly orders were issued transferring the entire propaganda work

done hitherto by the Agricultural Department to the Cooperative Department and confining the activities of the Agricultural Department to agricultural research and education. The most outstanding feature of the new scheme of rural development is that it recognizes the cooperative movement as the most suitable agency for propaganda, for disseminating agricultural knowledge and bringing the results of the specialized research work of departments like the Agricultural Department within reach of the masses. The improvement of agricultural production by popularizing scientific and cooperative methods, the provision for economical and efficient marketing of the agricultural produce through regulation of marketing in general and through coordinated cooperative marketing in particular, the organization of supplies to the rural population through the agency of cooperative multi-purpose societies and through cooperative organizations of rural cottage industries are some of the main features visualized in the new scheme of rural economic development. For propaganda work in villages the scheme visualizes the employment of about 1,000 rural reconstruction workers after training in various subjects affecting rural life.

United Provinces. The total number of societies including 70 central banks increased from 9,125 to 10,858 and their membership increased from 382,254 to 699,036. The working capital increased from Rs. 3,02,92,958 to Rs. 3,20,65,604. There was a welcome increase of member societies of central banks by 641 to 8,167. This increase is reflected in the increase in the working capital figures of the central banks by Rs. 7·32 lakhs over last year's figures, their owned capital forming more than 39 per cent working capital. The number of central non-credit societies increased within the year from 77 to 117 and individual membership from 35,489 to 169,691 ; simultaneously the number of member societies has gone up by 368 from 1,884 to 2,252. The accelerated increase in the membership is due to the increase in the number of cane societies. The working capital of these societies has fallen from Rs. 25·91 lakhs to Rs. 11·11 lakhs. A similar fall is noticeable in the case of owned capital which shows a decrease from Rs. 12·66 lakhs to Rs. 1·67 lakhs. Both these decreases are entirely due to the liquidation of the Biswan Cooperative Sugar Factory which had Rs. 21·37 lakhs as its working capital and Rs. 11·26 lakhs as its owned capital. Deducting the amount of the working and the owned capital of the Biswan Cooperative Sugar Factory from the corresponding figures for the year as well as from those for the year previous to that, it will be noticed that instead of any decrease in the working and the owned capital of the existing societies there has been in fact a rise in both the figures. The figures given above do not, therefore, represent the true state of affairs with respect to the existing societies.

The policy of steady development of agricultural primaries consistent with our resources for supervision and audit was followed throughout the year and was reflected in the rise all along the line. The number of primaries (agricultural) went up to 10,026 from 8,439 and the membership from 271,520 to 452,865. In these societies there has also been a rise of about Rs. 16 lakhs in the working capital and by about Rs. 3½ lakhs in the owned capital. Membership in these societies has risen by about 66 per cent, but neither the working nor the owned capitals have followed that pace. The increase in the case of working and owned capital has been only 13·4 per cent and 5·08 per cent respectively. This is due to the fact that the working capital of cane societies is at its

lowest at the end of the year when the figures are collected and better living societies mean large membership but little capital. The number of primary non-agricultural societies rose by 98 to 645 and the membership from ·60 to ·69 lakh. A corresponding increase both in the working and owned capital has been registered, the former rising by Rs. 9·29 lakhs and the latter by Rs. 3·68 lakhs. The increase in the capital has kept full pace with the increase in the membership. The notable feature in this case is the increase in the owned capital to about 39·7 per cent of the increase in the working capital. The total percentage of owned capital to the working capital is 47 per cent. The average of membership in primary agricultural societies in general has registered a pleasant rise from 32·1 to 45·2, while the average in credit societies has risen to 23·8 against 23·2 of the year before. Taking the agricultural and non-agricultural societies together, the average membership per society has risen to 48·9 from 36·9. The total capital invested in the movement during the year increased from Rs. 2·22 crores to Rs. 2·27 crores.

The number of central credit societies inclusive of banking unions decreased from 72 to 70. This is due to the amalgamation of the Gola Central Cooperative Bank with the Kheri Central District Cooperative Bank and of the Jehangirabad Central Bank having been liquidated. The working capital of Central Banks increased from Rs. 94·87 to Rs. 102·19 lakhs. The percentage of the owned capital to the working capital comes to 39·1 per cent against 41·9 per cent last year. Although the percentage of owned capital to borrowed capital has decreased from the year previous, the net amount of owned capital has increased from Rs. 39·82 to Rs. 39·98 lakhs. The decrease in the percentage is explained by a proportionately higher increase in the borrowed capital as a result of the fact that a number of banks had to finance new societies organized within the year under report. The proportion, however, is well above the margin of safety. The liquid cover was generally adequate. Deposits from individuals rose from Rs. 43·15 to Rs. 49·63 lakhs. Deposits from banks rose from Rs. 3·50 to Rs. 4·06 lakhs and those of societies from Rs. 8·27 to Rs. 8·37 lakhs. The increase in the figures of deposits clearly shows that the cooperative banks with the exception of four or five as last year continued to enjoy public confidence and found little difficulty in raising deposits, when needed. The usual rate of interest on one year deposits was 3½ per cent. Some of the banks reduced it to as low as 1½ per cent.

Advances to primaries rose from Rs. 39·25 to Rs. 41·35 lakhs and recoveries from working societies have gone up from Rs. 33·93 to Rs. 35·14 lakhs, giving a percentage of 68·6 as against 61·3 of the preceding year. Overdues have simultaneously registered a fall from Rs 16·72 to Rs. 16·38 lakhs. The total demand including overdues of the previous year at the same time decreased from Rs. 55·38 to Rs. 51·26 lakhs. The percentage of collection from societies was more or less the same as last year. Recoveries from working and liquidated societies combined were 62·5 per cent as against 56·1 per cent of the year before. Overdues in relation to outstandings were 36·1 per cent against 41·5 per cent of the preceding year, 45·8 per cent of 1936-37, 49·2 per cent of 1935-36. Percentage of overdues to outstandings with the working societies alone was 30 as against 34·2 of 1937-38, 37·7 of 1936-37 and 41·8 of 1935-36. Overdue interest decreased from Rs. 3·48 lakhs to Rs. 3·41 lakhs in working societies and from Rs. 3·77 to Rs. 3·67 lakhs in liquidated societies. More than half of the overdue interest

in the working societies is due from the societies of Arya, Jarauli, Hardoi and Agra banks.

The number of land mortgage societies continued to be five, although membership during the year rose from 556 to 632 and advances to individuals from Rs. 41,900 to Rs. 49,985. The working of these societies cannot be regarded as satisfactory. Profits fell from Rs. 4,993 to Rs. 4,120. Overdues increased from Rs. 1,882 to Rs. 3,022 and recoveries went down from Rs. 15,513 to Rs. 14,852. The number of agricultural societies of unlimited liability registered during the year fell to 337 from 372 of last year. The total number of such societies working in the province after making allowances for those cancelled during the year was 7,213. The membership of these societies has risen to 1·71 lakhs from 1·60 lakhs. The average membership per society has risen from 23·0 to 23·7. The deposits held by members have further shown an increase from Rs. 2·78 to Rs. 3·24 lakhs. Various schemes for ensuring compulsory thrift are being adopted by the societies but we are still very far from the ideal of the societies raising their own capital from members' deposits. Those who have become members of our unlimited liability societies have little to spare by way of deposits, while those with better means do not join. Among other things, the fear of unlimited liability is undoubtedly responsible for this attitude of the mind.

The working capital of societies increased from Rs. 110·04 to Rs. 115·30 lakhs, owned capital alone increasing from Rs. 64·72 to Rs. 67·20 lakhs. Out of 7,213 societies, 67 per cent i.e., 4,858 have worked over 10 years. The number of societies which distributed dividend has gone down from 2,053 to 1,957. The societies which gave reduced rate of interest were 2,003 as against 1,789 of last year. The societies which worked at a loss were 313 only as compared with 660 of last year. The societies which did not finance their members or in which members did not apply for loan fell to 1,623 from 1,667. Again the number of these societies which had 100 per cent overdues against members have gone down from 1,445 to 1,375. The number of societies in arrears of interest to central banks went up from 931 to 947 : the amount of overdue interest increased from Rs. 3·42 to Rs. 3·47 lakhs. The general position continued to be encouraging as the above figures go to show that more attention has now been paid towards consolidating the societies and developing their resources and towards internal advancement than towards distribution of dividend.

There were 32 central stores during the year as compared with 23 of the year before. Twenty of these stores were for the supply of seeds, eight for the supply of improved agricultural implements and four for the supply of raw material to weavers. Of the primary stores there were 42 in the whole province during the year. Fifteen of these primary stores were for the distribution of improved seeds, two of them taking up marketing work as well. Of the remaining 27, six stores supplied raw material to weavers, nine were organized by students and 12 were general stores for the supply of miscellaneous articles.

The number of ghee societies rose from 277 to 392 and membership from 5,791 to 9,301. In addition to the above number of primary societies, there were five central ghee unions in existence. These societies are spread over seven districts, namely Etawah (139), Mainpuri (89), Agra (78), Bulandshahr (40), Meerut (25), Muttra (15) and Jalaun (6). The total quantity of ghee marketed by these societies was about 4,870 mds. as against 4,305 mds. of last year resulting

in a net profit of Rs. 28,565. Rs. 5,817 were paid to the members in bonuses. The number of cane supply societies increased to 42 central and 681 primary societies, as against 28 and 477 respectively of 1937-38. The membership of these societies now consists of 3·71 lakhs persons. The highest number of central societies in any one district, namely 26, is in Gorakhpur and in the number of primary societies also Gorakhpur leads where no less than 268 primaries are found.

The development scheme is in existence now in 114 zones comprising of 9,594 villages. These zones supplied cane to 49 factories within their range and succeeded in supplying 476 lakh maunds out of the total of 924 lakh maunds of cane crushed, 35·39 lakh maunds of cane seed and 1·54 lakh maunds of fertilizers were supplied through societies. In the western range alone, 4,380 mds. of *sanai* seed for green manuring was distributed and no less than 12,000 acres of land was green-manured. In the western and central ranges 5,298 improved implements were distributed. Quite a number of village activities were taken up by the societies of all the three ranges.

Village uplift work continued to exercise the minds of ordinary cooperative societies and the number of societies doing welfare work rose from 549 to 1,436. Most of these societies are for better living. The results achieved by them are worthy of note.

The number of societies for consolidation of holdings rose from 118 to 147, the major portion of the work being done in Bijnor and Saharanpur. Sixteen supervisors were employed by the United Provinces Cooperative Union for this work. Twelve thousand and seventy five bighas were consolidated during the year. The number of plots before operations started was 12,822 and was reduced to 1,672 after consolidation. The total area consolidated so far is 67,000 bighas, the number of plots having been reduced to 7,599 from 75,965.

PUNJAB. Societies numbered 24,322 with a membership of 965,515 and with a working capital of Rs. 17·14 crores. The number of agricultural societies was 19·401 with a membership of 726,419, the working capital being Rs. 7·23 crores. The increase in the total number of societies and members over the previous year was 655 and 51,075 respectively. This expansion compares favourably with the increase of the previous year. Some of the increase in membership was no doubt due to bringing into societies as members the heirs of deceased members, but the tendency for new members to join old societies was particularly noticeable during the year. The non-credit type of society found greater favour and contributed materially to the increase in the number of societies. The fall in the total working capital from Rs. 18·24 crores to Rs. 17·14 crores was due to the adoption of the new procedure according to which undistributed profits are not included in working capital.

Increase in the loan business of agricultural societies noticed in the previous year was maintained. These societies advanced Rs. 1·11 crores to their members as against Rs. 1·06 crores in the previous year. The advances of central banks and unions to the affiliated societies were Rs. 2·46 crores as against Rs. 2·50 crores in the previous year. The upward trend of r coveries in agricultural societies was maintained. The amount on loan due from members of these societies was Rs. 616·40 lakhs at the end of the year as against Rs. 620·45 lakhs at the close of the previous year, thus showing a net decrease of Rs. 4 lakhs in indebtedness. The work of recoveries continued to fall more and more heavily

on the shoulders of departmental officers, non-officials not coming forward to shoulder their share of responsibility in this connection.

Educational work was continued throughout the year and was also extended to a certain extent. The staff consisted of an Educational Assistant Registrar, six Inspectors, eight Assistants, one Education Sub-Inspectress and one Industrial Educational Assistant. The educational staff did a lot of touring. Ninety-five classes were attended by 1,344 secretaries. Besides training in accounts and business methods, general training in cooperation is given to these men. 195 classes were attended by 6,799 office-holders. At these classes general education regarding cooperation, practical training in the work of societies and a general idea of the responsibility and the duties of office-holders were given. One hundred and sixty-seven lectures were given to public gatherings and 105 in schools and colleges. The drama party gave 166 shows at 139 places and it is estimated that a million men and 15,000 women witnessed the performances. Eighty-seven articles and 115 press notes were issued, 13 pamphlets were written and 39 new poems were set to music for use by the drama party and on the wireless. Magic lantern slides were also shown at various places.

The working capital of the Provincial Bank amounted to about Rs. 148 lakhs. Loans and deposits held amounted to nearly Rs. 125 lakhs, of which the bulk was from central banks and unions. The total outstanding of fixed loans granted to these bodies at the end of the year was Rs. 40·83 lakhs and the amount of cash eredit was Rs. 3·28 lakhs. The bank's position was sound and it was in a position to meet all legitimate needs of central institutions. Its reserves are being continually strengthened. The number of central banks was 48 and that of banking unions was 68. There were also four industrial unions. The working capital was Rs. 651 lakhs, as against Rs. 658 lakhs in the previous year. Most of the banks in south-east Punjab showed a loss. Except in these banks, the departmental standard for fluid resources was well maintained. The amount held in suspense on account of interest overdue has steadily increased.

Rs. 63·08 lakhs were lent to 6,895 societies as against Rs. 61·34 lakhs to 6,323 societies in the previous year. 11,541 societies did not borrow during the year as against 12,223 in the previous year. 2,207 did not borrow because they had adequate funds, 5,007 because they were defaulters and 4,327 for other reasons. The total amount outstanding at the end of the year was Rs. 3,72,49,000 principal and Rs. 53,37,000 interest as against Rs. 3,74,16,000 principal and Rs. 46,93,000 interest at the beginning of the year. Interest arrears went up by nearly Rs. 6½ lakhs, while principal decreased by a little over Rs. 1½ lahks. Central banks gave relief to members societies to as large an extent as possible. Various schemes of concession also continued to be worked out. There were ten land mortgage banks working, while two were under liquidation. The total working capital of the mortgage banks was reduced from Rs. 14·10 lakhs to Rs. 13·40 lakhs. The position of these banks was not encouraging. In the case of agricultural societies with unlimited credit, the policy followed was one of consolidation rather than of expansion. A larger percentage of loans was being given mostly for crops and cattle and loans for repayment of debt and for purchase and redemption of land have shown a tendency to decline.

There were 313 cattle breeding, 25 sheep-breeding and 14 mule breeding

societies and three district associations. There were 183 better farming, 26 fruit plantation and 63 land reclamation societies. Better farming societies did almost nothing jointly and only did the work of distribution and cultivation of improved seed. One hundred and ninty-two societies for the consolidation of holdings with a membership of 25,241 were registered during the year. The total number of such registered societies was 1,477 at the end of the year, and the total area consolidated up to 31st July 1939 was 10,76,034. There were 20 commission shops, two sale societies, one sale union and two marketing organizations. The number of crop failure societies was 91 and 90 out of these were in Hoshiarpur. Special development schemes were put in operation in the course of the year and Rs. 3,68,516 were spent on work connected with them. The number of better living societies increased from 1,084 to 1,318 and the membership from 50,793 to 62,578 in the course of the year. There were four Inspectors and 69 Sub-Inspectors on non-credit work in different parts of the province. Eight Public Health and Medical Aid societies, with a total membership of 863, were registered by the close of the year.

BIHAR. The financial position of the Provincial Cooperative Bank, Ltd., received a further set-back during the year. In consequence of comparatively heavy refund of deposits, the working capital of the bank, which at the end of 1937 stood at Rs. 99,51,075, was reduced to Rs. 96,30,144. Owing to poor recovery from Central Banks, the Provincial Coöperative Bank had to meet the demand for refund mostly by the sale of Government securities. As no distributable profits were available, no dividend was paid during the year. The statutory reserve fund increased by Rs. 10,410 only from Rs. 4,43,935 at the end of 1937 to Rs. 4,54,345, while the reserve for contingencies rose from Rs. 2,34,900 to Rs. 3,78,100. There was a further fall by Rs. 4,67,000 during the year in the total deposits held by the bank which stood at Rs. 64,27,000 at the close of the year. The decrease in total deposits in the bank during the past four years ending 31 December 1938 amounts to Rs. 16,03,000. Out of the two loans amounting to Rs. 20 lakhs given by the Government to the bank in the year 1934, Rs. 13,80,000 remained due for payment at the close of the year under review. Due to financial embarrassments of the bank, the instalments due in 1938 could not be repaid and Government were pleased to grant an extension of the period of payment by one year. A sum of Rs. 20,000 was also due to Government out of the loan of Rs. 30,000 given to the bank for financing canegrowers' societies. The instalments of this loan are being regularly paid.

The bank continued to be handicapped by the heavy overdues from central banks and unions. The total demand from central banks and societies in Bihar during the year, including the overdues of the previous year, was Rs. 43,16,000 out of which Rs. 75,000 only was realized, leaving a sum of Rs. 42,41,000 as overdue. Out of the amount of Rs. 8,67,000 due as interest from central banks in Bihar Rs. 1,40,000 only during the year was realized, leaving Rs. 7,27,000 as overdue.

The number of central banks and unions was 53 as in the previous year. The paid-up share capital, which stood at Rs. 16·26 lakhs at the end of the previous year, went down to Rs. 16·22 lakhs at the close of the year. There was thus a drop of Rs. 4,167 as against Rs. 7,724 during the previous year. The working capital also decreased by Rs. 2·73 lakhs and stood at Rs. 1,64,49,846

at the end of the year. The paid-up share capital and reserves formed 9·8 and 8·3 *per cent respectively of the working capital.* The *total statutory reserve* stood at Rs. 7,38,777, being only 4·5 per cent of the working capital. The proportion of owned to borrowed capital was 1 : 4·5.

There was general run on the banks for withdrawal of deposits by individual members. Owing to acute financial difficulties most of them were unable to meet their obligations to their creditors. Thirteen banks had recourse to creditors' meetings under section 24-A of the Bihar and Orissa Cooperative Societies Act and the compromise arrived at there have been given effect to.

The Annual Reports of the Central Cooperative Banks and Unions for the period under review reveal that only 31 out of 53 interested themselves in agricultural improvements in their areas. *Kamdars* were employed by the Siwan, the Gumla, the Dumka and the Khunti Central Unions for popularizing improved methods of cultivation in society villages by distributing improved seeds, agricultural implements and manures as advised by the Department of Agriculture from time to time. A number of useful demonstrations in the cultivation of different varieties of crops were carried on by other banks with the assistance of overseers and *kamdars* of the agricultural department. The Bihar *Central Cooperative Bank sold 395¼ mds. of gypsum to members* and non-members, while cotton seeds of an improved type were distributed free by the Deoghar Central Cooperative Union among its members. Due to lack of funds for long term investments, advances by banks and unions to societies and by the latter to their members for improvement of lands had to be curtailed. Seventeen banks are reported to have adopted certain measures for the improvement of sanitation and for medical relief.

The activities of the Department in promoting mass literacy in the province deserves special mention. Two hundred and seven literacy centres worked through the efforts of cooperative institutions, while the number of persons made literate was in the neighbourhood of 3,387. As the banks were busy in setting their own houses in order, nothing appreciable could be achieved in the direction of rural reconstruction. The programme of rural reconstruction had, therefore, to be carried on mainly through the four rural welfare centres under the Bihar village welfare scheme run by the Department. Village sanitation received due attention during the period and efforts were made to teach the villagers how to keep their neighbourhood free from filth and dirt. *Preparation of soakage pits, disinfection of wells and inoculation of children* and cattle were encouraged in all the villages under these centres. During the year 169 ditches at Kuru were filled up as against 26 in the previous year. Fortnightly cleaning of villages is being continued. Fifty-three primary vaccinations were given in the Mihijam welfare centre and 70 at Kuru where 72 revaccinations were also made. Wells were disinfected in each of these centres and in some of them new wells were sunk. New roads totalling a distance of five miles were constructed at Kuru as against two miles in the previous year. Old roads covering a distance of 8¾ miles were repaired, as against 2¼ miles last year.

The total number of agricultural societies of all types was 7,039 as against 6,790 at the close of the previous year. There was also an increase in the membership of these societies by 7,791, the total number at the end of the year being 169,078. The paid-up share capital and the working capital amounted to

Rs. 11·24 lakhs and Rs. 147·12 lakhs respectively as against 11·22 lakhs and Rs. 148 lakhs in the previous year. The slight decrease in the working capital was due to liquidation of a number of societies and the inability of the central cooperative banks to make further advances. There was an increase of Rs. 79 lakhs in the statutory reserves which stood at Rs. 26,64,357. The amount of other funds also increased by Rs. 18,000 to Rs. 1·22 lakhs. The owned capital amounted to 26·5 per cent of the working capital. The number of primary credit societies with unlimited liability increased by 69 to 6,628 and the membership, which also increased by 3,167, stood at 1,52,873. The aggregate working capital and reserves of these societies were Rs. 1,47 and Rs. 27·62 lakhs respectively as against Rs. 147·41 and Rs. 28·66 lakhs respectively in 1937. The amount of loans advanced during the year was Rs. 2·51 lakhs against Rs. 2·52 lakhs in the previous year. The cost of management was Rs. 0·76 as against Rs. 0·88 in 1937.

The scheme for the organization and the operation of Canegrowers' Cooperative Societies, which came into operation in 1935, was further extended from 1 April 1938 to 31 March 1941. There was an appreciable improvement in business relations between the canegrowers' associations and the sugar factories, though instances of lack of cooperation and general feeling of distrust against these societies on part of some of the mills were not also entirely lacking. During the crushing season 1938-39, 372 canegrowers' societies and 12 marketing unions with 7,782 members supplied 13,69,683 mds. of cane. Adequate attention was paid to the introduction and propagation of improved varieties of sugarcane and agricultural implements which are gaining popularity among canegrowers. Every member of every Canegrowers' Cooperative Society is being encouraged to maintain manure pits and compost heaps. As a result of the efforts of the fields staff, the cultivators are becoming more and more conscious of the utility of purchasing seeds of improved varieties for which there is an increasing demand. Lantern lectures on sanitation, hygiene, child-welfare, improvement of village communication and allied subjects were delivered in a number of canegrowers' societies and in some societies arrangements were made for training 19 village *dais* in maternity work with the help of a midwife employed by the District Board. Other activities undertaken by the members of societies were vegetable gardening, construction and repair of village communications by joint efforts and contributions made by them for arrangements for supply of good drinking water. *Eri*-rearing and spinning as cottage industries were also introduced in some of the societies and for this purpose the Department of Industries placed, on a temporary basis, the services of an *Eri*-instructor at the disposal of the Special Officer, Canegrowers' Cooperative Societies, Pusa. Improved varieties of canes were also supplied free by the Agricultural Department, and demonstrations in selected areas were given by Agricultural Overseers and *Kamdars*.

The Cooperative Training Institute was reorganized on a residential basis during the period under review. It was shifted in October 1937 to Pusa where suitable buildings for a residential Institute of this kind and an excellent environment for a corporate life are available. A short course of special training for the rehabilitation enquiry was also arranged at the Institute for 25 departmental inspectors towards the close of March 1938. A number of lectures were delivered by the Registrar, Cooperative Societies, and the Banking Expert and

subsequently the inspectors were taken to Laheriasarai for practical training in the work of rehabilitation enquiry. After the necessary training they were deputed to field work in connection with the rehabilitation enquiries started towards the end of March 1938. The Institute also organized a special course of training for the additional special officers, Organizers and Supervisors of the Canegrowers' Cooperative Societies, appointed under the revised scheme for the cooperative organization of canegrowers. Training classes for *panches* and members of primary societies were held in nearly 280 centres and about 4,900 members including secretaries and *panches* were trained in cooperative principles, self-help, village uplift and book-keeping. Lessons on primary education, manuring, tilling, better farming etc., were also given. Several hundred manure pits were actually prepared by way of demonstration in the course of this training.

Central Provinces and Berar. The year was as unfavourable to the agriculturists as the previous one, the cotton tract of the province suffering the most. As a result, the outturn and the prices of the principal crops were unsatisfactory, recoveries were poor and the movement suffered a further setback, more particularly in Berar where nine banks were forced to suspend business during the latter part of the year. The position of the movement in Berar became extremely grave and financial accommodation and land management continued to be the main problems there. The committee appointed to suggest remedies for the situation submitted its report in February 1939. The scheme proposed by Government for the rehabilitation of the movement in Berar did not find favour with the public concerned and the question of dissolving the crisis in Berar continued to engage the serious attention of Government.

The total number of primary societies with limited and unlimited liability increased by 288 to 4,372, of which 3,664 were in the Central Provinces and 708 in Berar. The total working capital of societies excluding those under liquidation decreased from Rs. 105 lakhs to Rs. 92 lakhs. The decrease in the Central Provinces was from Rs. 53 lakhs to Rs. 52·59 lakhs and in Berar it was from Rs. 52 lakhs to Rs. 39 lakhs. The loans due by members also fell from Rs. 81·26 lakhs to Rs. 69·15 lakhs. Cash recoveries from members of working societies, however, increased from Rs. 7·88 lakhs to Rs. 8·49 lakhs in the Central Provinces and decreased from Rs. 2·58 lakhs to Rs. 1·69 lakhs in Berar. The membership of societies, other than those under liquidation, increased from 45,983 to 50,411 in the Central Provinces and decreased in Berar from 7,316 to 7,289. Total loans advanced by societies to members decreased from Rs. 19·78 lakhs to Rs. 16·39 lakhs, about half of which were cash advances. The proportion of overdues in the loans of societies against members has been slightly reduced in the province as a whole. It has gone up in Berar. The work of reorganizing societies was continued, but the progress was as unsatisfactory as in the previous year. Deposits in societies showed a further decrease. There was an increase in the Central Provinces, but the fall in Berar was due to the economic depression and to the deplorable condition of the movement in that part.

Two more land mortgage banks were registered during the year and the total number of land mortgage banks in the province increased from 19 to 21. The total working capital of the banks was Rs. 12·86 lakhs, showing an increase

over the previous year of about Rs. 4½ lakhs. Though the number of applications for loans, viz., 1,183, was smaller by about three hundred than in the preceding year, the amount of loans advanced showed an increase, Rs. 4·47 lakhs being advanced as against Rs. 3·79 lakhs in the preceding year. The percentage of overdues on the balance of loan outstanding against borrowers at the close of the year was 3·4 and that of defaulting borrowers on the total number of members 7·9. The increase of overdues was due partly to the failure of crops in some parts of the province and partly to deliberate defaults. The Central Provinces and Berar Provincial Cooperative Bank continued to function as an apex bank for the land mortgage bank movement and financed all land mortgage banks. The total value of the different series of debentures floated by the bank till 30 June 1939 was Rs. 8 lakhs, while the balance of the loan outstanding against all land mortgage banks was Rs. 10·88 lakhs.

The total working capital of the 35 central banks decreased by about Rs. 2½ lakhs to Rs. 2·43 crores. The share capital also showed a slight decline. Reserve and other funds, however, increased to Rs. 54·20 lakhs and of this, a sum of Rs. 34 lakhs was earmarked for provision for bad and doubtful debts. The percentage of bad debts to the total loans outstanding worked out in the Central Provinces at 23·3 and in Berar at 49. There was a marked decrease of deposits in all the banks in Berar. Central banks in Berar, except three, could not meet the demand of depositors in time and the overdue deposits on 30 June 1939 amounted to Rs. 8·33 lakhs. The working capital of the Provincial Bank increased to Rs. 167 lakhs and the net profits also showed an increase. The amount due from central banks and societies on account of loans, cash credits and overdraft accounts increased from Rs. 37·22 lakhs to Rs. 45·79 lakhs. The financial position of the bank was sound and its policy was cautious.

ASSAM. The movement passed through another year of acute distress. In spite of various odds, the Department tried its best to bring in improvement steadily and continued the policy of consolidation and cautious expansion. Weather conditions were not very favourable during the year. Sudden floods early in July 1938 in the Assam Valley and in the Surma Valley in October 1938 caused failure of crops. This is to some extent responsible for inadequate collections from members of the cooperative societies during the year. In spite of some rise in the price level of crops, there was hardly any improvement in the collection of dues of the cooperative societies, and the prospect of recovery continued to be as gloomy as in the previous years.

During the year, 83 new societies including 57 agricultural credit societies and 26 non-agricultural credit societies were registered and 27 societies were sent to liquidation. The total number of societies thus rose from 1,495 to 1,551, recording a net increase of 56 societies from the previous year. The demand for organisation of societies is constantly increasing. But in the absence of an adequate staff for proper supervision and most of the banks not having been in a position to take up fresh financing, a very cautious policy had to be followed in new organization. During the year, the total number of members of all classes decreased from 62,425 to 61,624. In spite of gradual increase in the number of societies, there has been a decrease in the number of members. The total working capital of classes of societies continued to decrease from Rs. 90,20,280 to Rs. 88,21,352, *i.e.*, a decrease of Rs. 1,98,928, as against Rs. 28,992 of the previous year. As in the previous year, the decrease in the

working capital is mainly due to the reduction in the working capital of agricultural societies amounting to Rs. 1,64,925 as against Rs. 83,761 in the previous year. The actual transactions of credit societies of all classes show that new loans to the extent of Rs. 9,69,012 were issued to them as against 9,78,013 and recoveries amounted to Rs. 9,82,701 as against Rs. 10,09,497 in the previous year. The recoveries from the members of the agricultural societies and land mortgage banks decreased from Rs. 1,62,855 and Rs. 41,821 to Rs. 1,56,575 and Rs. 19,077 respectively, but the recoveries in the non-agricultural societies slightly increased from Rs. 8,04,821 to Rs. 8,07,049.

The total loans due by individual members stood at Rs. 16,46,675 and Rs. 19,16,431 in the agricultural and non-agricultural societies as against Rs. 17,85,813 and Rs. 18,74,614 respectively in the preceding year. In the Land Mortgage Banks, the total loans due by individual members decreased from Rs. 3,08,890 to Rs. 2,90,659 of which Rs. 2,83,354 was overdue, *i.e.*, near about 98 per cent as in the previous year. The overdues in the agricultural societies stood at 93 per cent as against 94 per cent in the previous year and those in the non-agricultural societies further decreased to 36 per cent from 39 per cent in the preceding year. The position in the agricultural societies and land mortgage banks is still continuing to be alarming. These overdues are the accumulated results of the past decade and with the stopping of fresh financing, the members have become more indifferent and in many cases definitely hostile towards the movement. The Department and financing banks are continuing in their strenuous tasks of realizing the long overdues with little hopes of success. Various measures of relief were adopted to solve the situation. Reduction in the rate of interest charged to members, writing off of dues, where payments are made within specified periods and other reliefs granted to members without any appreciable results. Unless the repaying capacity of the agriculturist is improved, some immediate financial help is given for normal expenses, outstanding dues are scaled down and then borrowers allowed to pay their dues in easy instalments within a number of years, the position cannot improve. The Department is continuing in its efforts of introducing subsidiary occupations. But with inadequate staff the task seems an impossibility.

In spite of the most unfavourable state of the cooperative movement in the province, the Provincial Cooperative Bank of Assam, Ltd., continued on its satisfactory position. The subscribed and paid-up capital of the Bank increased from Rs. 2,20,800 and Rs. 1,10,400 to Rs. 2,23,700 and Rs. 1,11,850 respectively. The amount of share capital held by preference share-holders was reduced by Rs. 1,050 on account of withdrawal, but the ordinary share capital was contributed to and an additional sum of Rs. 2,500 was recorded. Deposits held at the end of the year from all sources increased from Rs. 1,98,067 to Rs. 2,06,460 excluding the overdraft of Rs. 22,904 at the close of the year. Deposits received and refunded during the year amounted to Rs. 55,743 and Rs. 47,550 against Rs. 82,252 and Rs. 73,356 respectively in the preceding year. The working capital increased from Rs. 3,67,186 to Rs. 3,85,337. The paid-up share capital is about 54 per cent of the amount of deposits held by the Bank against 55 per cent in the preceding year. Loans issued during the year amounted to Rs. 71,292 as against Rs. 1,01,500 in the preceding year. As in the previous year, most of these loans were taken for refund of deposits bearing high rates of interest. The recovery of loans and collection of interest

respectively amounted to Rs. 51,282 and Rs. 17,378 as against Rs. 50,765 and Rs. 12,262 in the preceding year. As the recovery of loans was not satisfactory and inflow of deposits comparatively lower than in previous years, the bank had hardly any resource for fresh finance and had to adopt a very cautious policy in granting loans to the societies. The total loans outstanding at the close of the year amounted to Rs. 2,80,708 against Rs. 2,61,098 of which Rs. 1,21,983 or 43 per cent was overdue as against 40 per cent in the previous year. The overdues include a sum of Rs. 11,281 due from societies under liquidation which earns no interest.

The total number of central banks continued to be 18 as in the previous year, of which five were in the Surma Valley and the remaining in the Assam Valley division. Almost all the central banks, except the central bank at Sibsagar and some of the smaller ones, are finding it difficult to maintain their credit and confidence in the midst of various adverse circumstances. There has not been any change in the position of Central Banks but on the contrary there were signs of further deterioration in most of them. The rate of interest on lending was reduced to stimulate collection, but there was no appreciable improvement in any. Due to the continued economic depression and the operations of the Assam Money Lenders Act and Debt Conciliation Boards in some of the places and also the hard competition of the Joint Stock Banks, the credit side of the movement has been greatly affected with the result that some of the Central Banks have been unable to meet their obligations to their depositors. In such a position of the financing agencies no expansion of the movement would be possible.

All the 18 central banks are employing their own supervisors. These central banks had in all 1,230 affiliated societies, and entertained 43 supervisors in all (with 5 more temporary hands) at an annual expenditure of Rs. 22,408 as against 44 supervisors and a cost of Rs. 20,759 in the previous year. Though the present state of affairs in the agricultural societies demands better and closer supervision, the central banks cannot increase the number of supervisors as due to the decrease in collections and profits and also in Government contribution, the banks have to reduce their working expenses. As in the previous year the Government contributed during the year Rs. 3,388 towards the cost of supervisors entertained by the central banks. Unless Government contribution is increased, it is difficult to increase the number of supervisors.

The total number of agricultural societies with unlimited liability increased further from 1,289 to 1,324 of which 670 were in Surma Valley and 654 in the Assam Valley, as against 658 and 631 respectively in the previous year. The number of members in the societies still continued to fall further from 42,383 to 41,189. The working capital of these societies was further reduced from Rs. 30,34,776 to Rs. 28,69,283. These societies issued loans to individual members to the extent of Rs. 88,789 as against Rs. 92,227 and recovered Rs. 1,56,573 as against Rs. 1,61,814 in the previous year. In spite of strenuous efforts on the part of the departmental officers and the financing banks, collections are gradually decreasing and the position is causing grave anxiety to the movement in general. The total loans due from members stood, at the close of the year, at Rs. 16,43,099 as against Rs. 17,81,114 of the previous year. The overdue amounts come to Rs. 15,26,977, *i.e.*, nearly 93 per cent as against 94 per cent in the previous year. All attempts are being directed to bring in a

revival of the situation but without Government help in the matter no substantial improvement is expected. Most of these agricultural credit societies are running at a loss. The profit and loss item of these societies shows that the net loss stood at Rs. 58,626 as against the net loss of Rs. 48,018 of the previous year. The position is indeed critical and threatens the very foundation of agricultural credit societies as the heavy losses thus incurred year after year are sure to wipe out the reserve fund of these societies in the near future. It has been urged that unless some preferential treatment is meted out to the cooperative societies exempting them from the Assam Moneylenders' Act and the Assam Debt Conciliation Act and the Government come forward with financial assistance the movement is likely to collapse.

As in previous years, five land mortgage banks continued their existence under extremely trying circumstances. The working of the banks has not improved and the collections during the year decreased considerably. The total amount of loans repaid by members was Rs. 19,077 as against Rs. 41,821 of the previous year. Only one bank could issue loans to the extent of Rs. 2,400. The total loans due from members stood at Rs. 2,90,659 of which Rs. 2,83,354 was overdue.

North-West Frontier Province. Agricultural conditions were not favourable and the prices of leading agricultural commodities continued at a very low level. The total number of societies increased from 753 to 822, the membership increased from 28 thousand to nearly 31 thousand and the working capital from Rs. 26·86 lakhs to Rs. 27·98 lakhs. The number of agricultural credit societies increased from 660 to 716. The total membership increased from 16,049 to 17,226 showing a net increase of 1,177. In view of the number of Inspectors and Sub-Inspectors, in both the circles, the rate of expansion was poor. Rs. 2·55 lakhs were lent to 4,488 members as compared with Rs. 2·46 lakhs and 4,142 members in the preceding year. Recoveries in the northern circle were 17·2 per cent against 16·4 per cent in the previous year and in the southern circle 19·8 per cent against 24·0 per cent in the preceding year. The amount overdue on 31 July 1939 was Rs. 1,56,575 principal and Rs. 2,39,557 interest. Out of the interest overdue, Rs. 2,02,584 is covered by the suspense interest account. Three societies have circle secretaries. In 53 societies Sub-Inspectors work as secretaries. 461 societies have trained secretaries, while 192 secretaries have not been trained as yet. 16 secretaries' classes were attended by 282 persons, while 15 office holders' classes were attended by 568 persons.

The three central banks at Hazara, Dera Ismail Khan and Mardan showed some progress during the year. The Bangash Cooperative Banking Union was also registered during the year and started work towards its close. The working capital of the central banks was Rs. 10·40 lakhs against Rs. 10·28 lakhs in the previous year. The position as regards deposits was satisfactory though members' deposits show a fall of Rs. 7, 000. The saving bank facilities provided by the banks have encouraged general thrift movement to a certain extent. 620 loans for Rs. 2·37 lakhs were granted to 372 societies. In the previons year 373 societies borrowed Rs. 1·89 lakhs. The amount on loan to societies increased from Rs. 7·12 lakhs to Rs. 7·37 lakhs during the year. Recoveries showed some improvement though overdues of principal and interest have increased, this being due to increased demand. The banks gave the

usual concessions such as rebate in interest and crediting recoveries to principal where necessary, etc.

Two cattle-breeding societies were registered during the year in the southern circle and they were working satisfactorily. Work in connection with the consolidation of holdings was in progress in 18 villages. Three societies with a total membership of 60 were registered during the year. The Sheikh Muhammadi Grape Sale Society did fairly good business in the course of the year. The Cooperative Egg Grading and Sale Association had 23 members. Over 47 lakhs of eggs worth Rs. 1·47 lakhs were sold during the year against 42½ lakhs valued at Rs. 1·84 lakhs in the previous year. Out of the 51 members of the Commission shop at Hathian only seven did not sell through the shop. It sold during the year 23,320 mds. goods worth Rs. 1·12 lakhs.

ORISSA. The movement continued to be stagnant in North Orissa and was marked by further decrease in membership and working capital. Membership and working capital recorded a small increase in banks and societies in South Orissa. The total number of societies increased from 2,686 to 2,704, the number of members showed a small rise from 103 thousand to 105 thousand and the working capital increased from Rs. 128·94 lakhs to Rs. 131·96 lakhs. Among the new societies registered during the year, the Orissa Provincial Cooperative Land Mortgage Bank was the most important. 26 other societies were also registered. The stagnation of the movement was responsible for further deterioration in the classification of societies in North Orissa. Societies in South Orissa showed a slight improvement in this respect.

The dispute regarding the bifurcation of the Bihar and Orissa Provincial Cooperative Bank was settled at a conference of representatives of the Governments of Bihar and Orissa and of the Bihar and Orissa Provincial Bank in August 1938. The Orissa Provincial Cooperative Bank which was registered in 1937 did not function. The Madras Provincial Cooperative Bank continued to be the apex bank for the two central banks in South Orissa but business was restricted to cash credit facilities only. The Provincial Cooperative Land Mortgage Bank started work at the end of February 1939. 26 applications for a total loan of Rs. 37,000 were received but no loans could be disbursed during the year.

The number of central banks remained the same as in the previous year, viz., 13 in North Orissa and two in South. The condition of the banks in North Orissa deteriorated further during the year. Government orders on the report of the enquiry into the condition of the cooperative movement were published only at the close of the year and members of societies withheld the payment of their dues pending the publication of Government decision in the hope of getting remissions and concessions recommended in the report. Very few fresh loans could be advanced for want of funds and the movement practically ceased to transact credit business, and came to a standstill. As a pleasing contrast to this state of affairs, the central banks in South Orissa showed improvement in their working. Overdues both of principal and interest mounted high and it was decided to grant remissions and reductions of overdue interest. The assistance which the banks used to render for encouraging agricultural improvement had to be curtailed or stopped owing to unfavourable financial conditions.

The number of agricultural societies at the end of the year was 2,506. Out of this number, 1,997 were in North Orissa and 509 in the South against 1,994 and 495 respectively in the previous year. Societies in the North advanced during the year Rs. 33 thousand and those in the South Rs. 358 thousand to their members. Owing to poor collections and no inflow of deposits into the banks, credit facilities were severely restricted.

The number of grain *golas* was 47 against 44 in the previous year. Their working capital was Rs. 2·70 lakhs against Rs. 2·63 lakhs in the previous year. Loans outstanding amounted in the two years were respectively Rs. 2·07 lakhs and Rs. 2 lakhs. Overdues out of these were respectively Rs. 2 lakhs and Rs. 1·96 lakhs. These figures show the deterioration that has taken place in the position of the *golas*. The nine purchase and sale societies had a working capital of Rs. 76 thousand against Rs. 71 thousand in the preceding year. These societies were originally started with the object of joint sale of agricultural produce of their members and of supplying them with agricultural and domestic requirements and small loans. Not one of the societies now perform the first part of their object. Four of them run small stores for supplying domestic requirements of members but the benefit is almost entirely confined to members living at the headquarters of the taluqs. The remaining five societies are merely credit societies and their work was not satisfactory either. Three production and sale societies were organized and registered during the year. They are connected with the sugarcaue and groundnut crops.

SIND. The number of societies decreased during the year by 72. There were 1,469 societies on 30 June 1938 and only five societies were newly registered during the year, bringing their total number to 1,474. Seventy-seven societies were put into liquidation leaving tbe net nnmber on 30 June 1939 at 1,397. The decrease is the largest in the number of agricultural societies being 50 out of 72. This was deemed necessary as a result of the policy of elimination of bad societies, which served as a bad example and were not serving any purpose. Under the orders of Government, the cases of all agricultural credit societies put into liquidation during the year were brought under review, for the purpose of reviving them as far as possible As a result of this re-examination, the liquidation orders of nine societies were revised by Government and the societies allowed to continue as living organizations, while 27 were considered hopeless of improvement and liquidation has been ordered to be continued, leaving 14 cases which are still under review. Membership has decreased from 77,765 last year to 75,765 during the year under review, giving a net decrease of 2,000. This is mainly due to the dismemberment of societies sent into liquidation and weeding out of contumacious defaulters and landless *haris* from the existing societies. Working capital, which is the most vital factor in the movement, shows a rise of Rs. 6,70,000, having risen from Rs. 3,21,51,756 to Rs. 3,28,21,756 as against the previous year's fall of Rs. 27,56,983. The chief factor responsible for the unprecedented decrease of the preceding year was the unhappy controversy between the Registrar and the Sind Provincial Bank. During the year under report, however, the bank gradually and steadfastly gained the lost ground as is evident from the rise of Rs. 13,61,399 in its deposits, from Rs. 60,43,958 to Rs. 74,05,357 as against the last year's fall of Rs. 29,22,510.

Broadly speaking, the progress of the movement as a whole, considering the severe crisis it had passed through in the previous year and the depression, can

by no means be regarded as unsatisfactory. While the fall in the number and membership of societies was due to weeding out of bad societies and contumacious defaulters and landless *haris*, the appreciable rise in the deposits of the Sind Provincial Bank and the Urban Banks and the consequent rise in the working capital marks the degree of public confidence restored in the higher institutions of this movement, viz., the Sind Provincial Bank and the Urban Banks. The movement during the year was on a fair way to regain its former position.

On 30 June 1938 there were in all 1,023 agricultural credit societies including the four zamindari banks. The number decreased to 973, 50 societies having been put into liquidation during the year and there being no new registration in accordance with the prevailing departmental policy of giving preference to consolidation. The number of members in the agricultural credit societies decreased from 25,957 to 24,528, giving a net fall of 1,429. This was due to the societies put into liquidation during the year. The total working capital of these societies decreased from Rs. 79·13 lakhs to Rs. 75·38 lakhs. The percentage of owned capital to working capital increased from 37 to 39·2 per cent giving a rise of 2·2 per cent which is accounted for by the fact that the outside capital, viz., the Bank loan, is gradually being withdrawn from societies. Due to frozen debts locked up with the members of primary agricultural credit societies for the past several years, it was not possible for the Sind Provincial Bank to afford fresh financial assistance to its constituent societies as in the past and the societies in their turn were obliged to withhold financial assistance to their own members.

The fall in the number of societies, their membership, reserve fund and working capital as also the gradual deterioration discerned by the rise in the percentage of arrears and corresponding fall in recoveries, poor audit classification, heavy rise in the number of cases referred to arbitration as also the number of awards sent up for execution by coercive processes constitute a set of factors which could make it appear as if the movement in Sind was almost hopeless, but as already stated the work of rehabilitation and rejuvenation of the movement has been taken in hand and no effort is spared to carry the movement through the existing trying conditions, by means of the programme chalked out.

As regards agricultural non-credit societies, no new society of this class was registered during the year. On the other hand, three societies (two seed and one sale) were put into liquidation bringing the number down from 31 to 28 during the year.

The Sind Provincial Cooperative Bank, which is not only the apex bank of the province but also the financing bank for all agricultural credit and other societies in Sind, continued to work under the nominated Committee of Management. The Registrar attended almost all the meetings of the Committee of Management. Action on the recommendations of Mr V. L. Mehta contained in his report was practically completed during the year. The bank advanced Rs. 2,98,018 to various societies and individual members of the bank, while the total repayments at the end of the year amounted to Rs. 11,15,116. Fresh loans to agricultural societies, non-agricultural societies, cooperative banks, urban societies and individuals amounted during the year to Rs. 23,175, Rs. 1,02,258, Rs. 32,434 and Rs. 1,37,391 respectively. Recovery of Rs. 3,04,391

from agricultural societies was not satisfactory. It shows a fall of Rs. 3,11,391 and Rs. 79,025 as compared with recoveries effected during 1936-37 and 1937-38 respectively. Cotton crop was damaged by early frost last year and the crop in parts of Sukkur district was destroyed by floods owing to breach in the Sind Canal. The prices of agricultural commodities last year were very low.

The number of better-living societies decreased from 135 of the previous year to 123 on 30 June 1939, 22 societies having been cancelled during the year. These societies with the lively programme of activities laid down in their by-laws could play a very useful part in rural uplift and the literacy campaign, had they at the outset been organized carefully with really enthusiastic people to run them. Almost all the societies are in a moribund condition.

DELHI. Twenty-six new societies were registered during the year, while two societies were transferred from the Punjab. New registrations included 11 agricultural credit, five non-agricultural credit, eight consolidation of holdings and two cattle breeding societies. Only three non-agricultural credit societies were put into liquidation. The number of newly registered societies was 19 in the previous year. The membership rose from 15,597 to 17,564. Working capital too increased by about Rs. 2½ lakhs although there was a fall again in the working capital of agricultural societies ; the non-agricultural societies showed an increase of more than Rs. 1½ lakhs. There was also an increase of Rs. 1 lakh in the Delhi Province Central Bank. Setting apart of overdue interest to suspense interest account, which has put the societies on sounder financial condition is the major cause of the small fall in the working capital of agricultural societies.

The Delhi Province Central Cooperative Bank, Ltd., continued to finance the whole of the movement in the province and in addition financed some societies of Palwal and Ballabgarh tehsils of Gurgaon district. It is the latter societies which have been the chief handicap to the central bank. The working capital of the bank was Rs. 14·5 lakhs as compared with Rs. 13·65 lakhs in the previous year. Deposits of all kinds increased from Rs. 10·8 lakhs to Rs. 11·7 lakhs during the year, in spite of the fact that the rate of interest of fixed deposits has been reduced from 2½ per cent to 2 per cent. Amount on loan to societies at the close of the year was Rs. 9·38 lakhs as compared with Rs. 9·21 lakhs at the beginning of the year. The amount of arrears of interest was Rs. 1·51 lakhs as compared with Rs. 1·25 lakhs in the previous year, which was due to bad agricultural conditions. Only six months' interest was recovered as compared with nine months' in the previous year. The fall in recovery was due to bad crops. The percentage of recoveries fell from 15·9 to 12. Overdue interest rose to the equivalent of 27½ months'. In the previous year it was equal to 23 months'.

With the appointment of a propaganda Sub-Inspector by the Delhi Central Bank, 11 new credit societies were started during the year while none was brought under liquidation. The total number of agricultural credit societies was 209 as compared with 198 in the previous year. The total assets of societies decreased from Rs. 178,000 to Rs. 152,000. The decrease in assets was due to a transfer of overdue interest amounting to Rs. 2,31,046 to the suspense interest account. The amount of loans due from members at the beginning of the year was Rs. 5,86,033 as compared with Rs. 5,85,220 at the close of the year. During the year Rs. 43,214 were advanced to 534 members,

while in the previous year the amount was Rs. 49,079 to 455 members. Recoveries of principal and interest went down heavily. Even the crop loans granted for one year could not be recovered in their entirety. Continuous famine was the main cause of this fall. The percentage of recoveries went down to 6·81 per cent while in the previous year it was 11·27 per cent. Overdues of both the principal and interest increased. Overdue interest was equal to 52½ months' interest at 9⅜ per cent, while last year it was equal to 45½ months', the major portion of overdue interest has been carried to suspense interest account. During the year Rs. 3,624 were written off as bad debts. One hundred and sixteen societies showed loss in their working, the chief cause being the suspense interest account. Several of these societies are in a hopeless condition, but owing to the unfavourable economic situation it was not thought desirable to cancel their registration.

Every possible effort was made to reduce the debtors' burden in societies. Concessions were granted by the central bank. The societies too extended relief to their members in the shape of reducing the rate of interest. On loans from 12½ per cent to 9⅜ per cent wherever funds permitted. A rebate of interest was allowed with retrospective effect. This concession was offered to 173 members of 12 societies but only 23 debtors took advantage of it, to the extent of Rs. 1,560 by paying Rs. 4,175 in cash. A rebate of one anna per rupee on the recoveries made in kind was given to the debtors by the societies in which central bank rules did not permit the amount to be given from central bank funds.

COORG. It is encouraging to note that the movement was able to keep up its progress despite the severity of the economic depression and the continued slump in paddy and coffee markets. The increase in the membership is a clear indication of the popularity and utility of the movement. The training classes conducted at all the important centres of Coorg during the year were very popular and proved to be of considerable help to members.' The inspectors and supervisors paid much attention to dormant societies keeping in view the policy of consolidation and rectification. Though the season was not altogether unfavourable, the paddy crop in high lying lands was very poor. In several cases Government granted relief either by way of remission or reduction of assessment, owing to the failure of the paddy crop.

The number of agricultural credit societies rose to 176 (174) during the year. The membership rose from 9,681 to 10,594 and share capital from Rs. 1,86,660 to Rs. 1,89,198. Deposits of members increased from Rs. 23,802 to Rs. 25,475 and of non-members from Rs. 57,086 to Rs. 62,338. The Government loan stood at Rs. 13,154 (Rs. 12,798) and loans and deposits from other societies and the central bank at Rs. 3,81,479 (Rs. 4,08,725). There was a large decrease in the loans advanced to members, the amount of the loan advanced being Rs. 1,10,090 as against Rs. 2,05,882 in the previous year. The fall is due mostly to the central bank's inability to accommodate the needs of the societies owing to the setback it received consequent on the crash of the Travancore National and Quilon Bank, Ltd. The demand under loans for the year was Rs. 3,17,750 (Rs. 3,37,094) excluding Rs. 7,948 for which time was granted. Out of this sum of Rs. 1,36,029 was collected leaving an overdue balance of Rs. 1,81,721. The percentage of collection works out to 42·81 (46·24) which shows a decrease when compared with the previous year.

There has been a considerable fall in the loans advanced to societies and member-depositors, from Rs. 1,28,795 to Rs. 68,290 and Rs. 15,937 to Rs. 10,694 respectively. The percentage of collection shows a fall from 69·50 to 62·64 during the year. The fall in prices of paddy and coffee failure of crops owing to erratic monsoon in some parts of Coorg and the general economic depression are the chief contributory causes for the drop in the collection.

The Debt Conciliation Board continued to do useful work without any legislative backing. It helped to scale down the debts of 14 persons amounting to Rs. 9,529 for Rs. 3,586 as against Rs. 23,214-3-3 for Rs. 16,594-8-0 in the previous year. With the passing of the new Debt Conciliation Act, it is hoped that the bank will play an important part in the conciliation of several frozen debts in the province. There was no change in the number of supervising union which stood at 13. All the unions did good work. There was a slight increase in the number of affiliated societies from 246 to 254. The working capital and the membership of the affiliated societies also show a rise from Rs. 8,03,500 to Rs. 8,16,420 and from 13,380 to 14,135 respectively.

MYSORE. The seasonal conditions during the year were far from satisfactory; nor was there any noticeable turn for the better in the economic condition of the people. Prices of commodities continued to be at the same low level as during the previous year.

The number of primary agricultural societies fell from 1,445 to 1,436 consequent on the weeding out of hopeless societies and the policy of cautious expansion adopted by the Department. The membership increased from 62,307 to 64,676 and the share and working capitals from Rs. 11·87 lakhs and Rs. 58·77 lakhs to Rs. 12·02 and Rs. 61·28 lakhs respectively. Out of the 1,436 societies, 1,325 were ordinary credit institutions, 37 land mortgage societies, 22 agricultural societies, 33 grain banks, 6 marketing societies and the rest miscellaneous institutions. The agricultural credit societies, including the land mortgage societies, had a membership of 62,644, a paid-up share capital of Rs. 11·82 lakhs, a deposit of Rs. 5·49 lakhs and total working capital of Rs. 60·32 lakhs. The loans issued amounted to Rs. 10·55 lakhs and recovered Rs. 9 lakhs as against Rs. 9·98 lakhs and Rs. 8·69 lakhs respectively in the previous year. The percentage of overdues to demand increased from 73·2 to 76·1.

The agricultural supply societies had a membership of 542 and a total working capital of Rs. 75,145. They showed no signs of improvement during the year and functioned more as credit institutions than as supply societies. There were five sale societies, one for the sale of figs, two for the sale of areca and two for cardamom at the beginning of the year. Two societies were added in the course of the year. The Maradihalli society is a typical cooperative cotton seed growers' association and did good business dufing the year. There were 33 grain banks with a membership of 1,029 and a working capital of Rs. 14,020 worth of grain and a reserve fund of Rs. 5,445. For want of proper facilities for stocking grain and lack of enthusiasm on the part of members these banks have not proved a success.

The Mysore Provincial Cooperative Apex Bank is the pivot of cooperative finance and is the sole agency for the grant of short-term and intermediate credit to the primary societies. The membership of the bank in respect of individuals decreased during the year from 240 to 212, but in respect of societies increased from 1,001 to 1,024 in spite of the cessation from membership of 15

societies consequent on their cancellation. The policy of eliminating individual shareholders and strengthening society membership is being steadily pursued to achieve the bank's ideal of a federation of societies. The deposits and the reserve fund stood at Rs. 25·29 lakhs and Rs. 1·74 lakhs respectively at the end of June 1939 as against Rs. 29·24 lakhs and Rs. 1·73 lakhs in the previous year. Loans issued to societies during the year amounted to Rs. 1·98 lakhs as against Rs. 1·76 lakhs in the previous year. The recoveries under principal fell from Rs. 1·71 lakhs to Rs. 1·69 lakhs, while under interest there was an increase from Rs. 1·26 lakhs to Rs. 1·38 lakhs. The percentage of overdues under all heads to the total outstandings was 79·12 as against 77·96 on 30 June 1938. The bank offered certain concessions to societies indebted to it in the matter of the reduction of interest and remission of penal interest, but only 400 societies were able to take advantage of the same. The working of the District Central Banks continued to be unsatisfactory and steps are being taken to close them one by one.

BARODA. The seasonal conditions were unfavourable in parts of the state. Everywhere, except in the Navasari district, rainfall was less than the decennial average and the yield of crops except *bajri* was below the normal expectation. Prices ruled low generally and thus the movement passed through one more bad year as these conditions tended to reduce the repaying capacity of members of societies.

The policy of the Department was thoroughly revised during the year. This included a complete overhaul of a large number of bad societies, cancellation of hopeless ones, organization of joint sale of produce and the introduction of the principle of controlled credit in some of the old societies and the registration of new ones exclusively on the lines of controlled credit. An important item in the programme of the Department was a close scrutiny into the affairs and the reconstruction of 145 societies during the year. At the beginning of the year, there were 1,139 societies. During the year 118 societies were newly registered and 13 were cancelled. The membership of the societies increased from 55,735 to 60,379 and the working capital from Rs. 91 lakhs to Rs. 95 lakhs. The number of agricultnral societies rose from 914 to 996 during the year and 812 of these were agricultural credit societies.

The Baroda Land Mortgage Bank continued its operations in six talukas of the Baroda district. The subscribed share capital of the bank rose from Rs. 1·09 lakhs to 1·11 lakhs. Out of 210 applications for loans, 111 were sanctioned and loans to the extent of Rs. 2 lakhs were advanced during the year as against 71 applications sanctioned out of 181 and the loan advances of Rs. 1·27 lakhs during the preceding year. The repayment of the instalments of loans was regular. The total outstanding loans at the end of the year amounted to Rs. 5·17 lakhs. The Navasari Land Mortgage Bank was registered and collected Rs. 15,540 towards subscription to 1,239 shares during the year. The bank will start regular work shortly. Out of the seven financing institutions, the Sidhpur taluka bank went into liquidation during the year. The total working capital of the banks was Rs. 14·90 lakhs as against Rs. 15·35 lakhs in the preceding year. Loans advanced during the year amounted to Rs. 3·38 lakhs as against Rs. 2·78 lakhs in the previous year. Loans outstanding at the end of the year amounted to Rs. 11·10 lakhs as against Rs. 11·14 lakhs in the preceding year. There was an increase in share capital,

reserve and other funds, but there was a decrease in deposits from societies and individuals and in loans from Government. Recoveries from agricultural societies were better in spite of low prices of agricultural produce.

At the beginning of the year there were 18 cotton sale societies. During the year 12 new societies were registered. The sale societies did good work. Their sales amounted to Rs. 7·08 lakhs as against Rs. 4·39 in the preceding year. Of the two ginning factories, only one worked. Out of 11 milch cattle societies, six were under liquidation. The agricultural thrift societies increased from 33 to 57 and of these, 55 were for women and 2 for men.

TRAVANCORE. The unfavourable seasonal and economic conditions contributed not a little to crippling the slender agricultural resources of the rural population. The movement had to face yet another year of slump in prices. The immediate problem which confronts the agricultural credit movement is how to bring about its rehabilitation by removing the causes of stagnation. Since most of the loans issued by societies in the past had been locked up in long term loans, fresh finance was not available to be given as loans to members as freely as was done in the earlier period of the movement. The dual task which the Department was called upon to shoulder was to resuscitate societies by effecting speedy recovery of loans and to restore the waning confidence of the public in the movement as a whole. In view of the hard times the Department favoured the granting of liberal concessions in the repayment of overdues. Hand in hand with the attempts at resuscitation, strenuous efforts were put forth to develop the non-credit side of the movement.

The Department continued the policy of rectification and consolidation of societies and of cautious expansion. The demand for the registration of fresh societies is very little and whenever there was demand, preference was given to the registration of non-credit societies. During the year 18 societies were registered out of which 17 were non-credit ones. The registration of 67 societies was cancelled during the year as against 66 in the previous year. Side by side with the policy of rectification and consolidation, a closer supervision and control over the work of societies was also sought to be achieved and the efforts made to improve them met with a certain measure of success. The total number of societies of all types at the end of the year was 1,655 as against 1,704 at the end of the previous year. The total number of societies at the end of the year was 1,636 out of which 1,500 did purely credit business.

During the year greater attention was devoted to the development of non-credit activities. Alongside of the Inspectors in charge of circles, the two non-credit Inspectors mainly engaged themselves in this behalf. During the year 17 non-credit societies were newly registered and several rural credit societies adopted as a side business such non-credit activities as joint purchase and sale, rural reconstruction work and 'kettuthengu' deposit system. The total working capital of all the societies fell from Rs. 84,58,447 to Rs. 79,34,873, the fall being Rs. 5,23,574. The fall is chiefly ascribable to the cancellation of a good number of societies including three big banks and to the repayment of share capital and deposits. Loans to the extent of Rs. 11·75 lakhs were given during the year. After a recovery of Rs. 14·5 lakhs, the year closed with an outstanding of Rs. 62·98 lakhs. Of this Rs. 37·51 lakhs were overdue as against Rs. 40·3 lakhs in the previous year.

There was a whole-hearted effort on the part of the Department to induce collection of overdues. In a few cases even payment in kind was encouraged. In very many deserving cases liberal concessions were given by way of remission of penalty and even interests were granted. The question of affording further relief to the heavily indebted members of societies was under consideration when the year closed.

The Trivandrum Central Cooperative Bank Limited continued to function as the apex financing institution. The bank strove hard to effect speedy recovery of overdues, though it could not make sufficient headway. The severe effects of the general economic depression had their natural repurcussions of the working of the bank. The primaries and taluq banks, not to mention the individual members, continued to be defaulters to the bank, and as a result of poor recoveries, the progress of the bank was considerably retarded.

There were at the end of the year 1,233 agricultural societies working with a membership of 1·29 lakhs and the working capital of Rs. 32·85 lakhs. There was a reduction in both as compared with the previous year. The percentage of arrears under loans was 79·2 as against 77·1 in the previous year. The organization and working of the Dairy and Cattle Breeding Societies on a cooperative basis are properly within the scope of and a necessary adjunct agricultural cooperation. There were seven societies under this category (four for dairying and three for cattle breeding) at the end of the year. Of these only two dairy societies and one cattle breeding society had started regular work.

In recent years, the tacking on of rural uplift to cooperative effort has caught the imagination of the people. There was a growing demand for the registration of rural reconstruction societies. The organization and working of sale societies to pool together and market the agricultural produce of the members engaged serious attention. During the year six societies of this type were registered. At the end of the year there were ten sale societies working.

COCHIN. The number of societies at the beginning of the year was 293. Thirty societies were registered during the year. The registration of nine societies was cancelled. Thus the number of societies at the end of the year was 314. Two hundred and sixty-five out of the 275 villages in the state are served by the movement. Excluding the 2,131 members of the central institutions the total number of members in the primary societies stood at 27,270 (of which 1,927 are women) giving an average of 98·4 per society, as against 25,068 and 94·95 per society repectively in the previous year. The total working capital of all the societies rose from Rs. 37,22,564 to Rs. 42,67,698; *i.e.*, by Rs. 5,45,134. The total transactions of the year rose from Rs. 1,09,85,556 to Rs. 1,28,54,204. The turnover worked at three times the working capital as against 2·95 in the previous year. A sum of Rs. 15,63,117 was loaned out during the year as against Rs. 15, 03,460 in the previous year.

Of the 166 societies holding shares in the central hank, 92 were of the agricultural type, 8 supervising unions and the rest non-agricultural societies. Deposits from individuals amounted to Rs. 5,84,832 against Rs. 6,22,083 in the previous year. The rate of interest paid varied from 1 to 4 per cent. The amount of loans issued by the central bank to societies was Rs. 1,05,408 in 115 cases against Rs. 57,741 in 86 cases during the previous year. The membership of the Cochin Cooperative Land Mortgage Bank rose from 1,540 to 1,828 and shares allotted from 7,272 to 7,569. The paid-up share capital was

Rs. 75,690 against Rs. 72,720 in the previous year. Loan applications to the value of Rs. 5,45,238 were pending disposal at the beginning of the year. Applications for Rs. 5,79,338 were received. The total for disposal was thus Rs. 11,24,576. Of these, applications to the value of Rs. 6,55,643 were disposed of, leaving applications to the value of Rs. 4,68,933 as pending investigation at the end of the year. The applications disallowed amounted to Rs. 2,01,619. The working capital and total transactions of the bank amounted to Rs. 12,43,614 and Rs. 28,97,957 against Rs. 9,27,213-14 and Rs. 25,56,199-4-7 respectively in the previous year. The transactions of the bank resulted in a net profit of Rs. 5,511.

During the year, the constitution of the Cochin Cooperative Institute underwent a thorough change. It has now become primarily a federation of all the supervising unions though urban banks and other types of societies and individuals are directly admitted. The Central Poultry Association continued to work satisfactorily, though the starting of the Rural Reconstruction Centre, Cherpu, as a department of the Government with paid officers and plenty of funds overlapped its activities. One more supervising union was registered during the year, making the total nine under this head. The eight unions had an aggregate membership of 100 (94) giving an average of 12·3 (11·7) societies per union. Snpervision fee collected amounted to Rs. 291 (329). Rural reconstruction societies were instrumental in advancing such cottage industries as weaving, beekeeping, poultry farming, basket weaving, mat weaving, etc. There were six societies of this type at the beginning of the year, making a total of 14 societies. Seven of these were not started when the year closed. The seven societies which were working had an aggregate membership of 334, a working capital of Rs. 2,195 and a total transaction of Rs. 7,295. Four societies earned a net profit of Rs. 71, while the remaining three worked at an aggregate loss of Rs. 35.

GWALIOR. The year marked the commencement of the formative phase of the cooperative movement in the state. The report on the enquiry into the condition of banks and societies was carefully examined and the recommendations made therein were accepted by the Durbar. The carrying out of the recommendations involved, among other things, the organization of cooperative education and training, the repeal of the Banks' Act and the enactment of a more comprehensive Cooperative Societies' Act and the establishment of an apex bank. A reforms section was created in the Cooperative Department and the task of reorganization was entrusted to it. Immediate start was made with the scheme of cooperative education and training. A special training class was organized at Poona for the training of teachers, Government and banks' officers and new candidates to be absorbed in state and banks' service. The Gwalior Cooperative Societies Bill was drafted and submitted to Government, and preparations were taken in hand for the organization of an apex bank. Other items in the reorganization programme were likewise undertaken.

During the year, the number of societies fell from 4,004 to 3,974, while their membership increased from 76,634 to 76,828 and their working capital from Rs. 68·15 to Rs. 71·12 lakhs. The fall in the number of societies is due to the continued policy of the Department to cancel unhealthy and defunct societies. In all 49 societies were cancelled during the year and 12 new societies were

registered. The number of agricultural credit societies decreased from 3,950 to 3,913: while their membership rose from 75,896 to 75,963 and their working capital from Rs. 66·90 to Rs. 66·76 lakhs. The owned capital of these societies rose from Rs. 33·86 lakhs to Rs. 35·73 lakhs, being 51·6 per cent of the working capital as against 50·5 per cent in the previous year. The total amount of loans advanced to members rose from Rs. 10·02 lakhs to Rs. 12·16 lakhs during the year. The total repayments by members to their societies amounted during the year to Rs. 13·79 as against Rs. 12·64 lakhs in the previous year. Overdues of principal increased from Rs. 35·09 to Rs. 35·28 lakhs. The scheme relating to the supply of pure and standard seed made steady progress. The Cooperative Commission Shop at Bhilsa did commendable work. The total number of grain stores at the end of the year was 138. Of these, 65 were in Bhilsa where efforts are being made to fit them within the framework of ordinary credit societies. There were 58 such societies and they had collected about 689 maunds of wheat.

There were 18 banks of which 11 were district banks and 7 *pargana* banks. The position of the banks, taken as a whole, showed an all-round improvement. The total amount of fresh loans advanced to societies was Rs. 11·75 lakhs against Rs. 9·40 lakhs in the preceding year. Repayments by societies on account of principal amounted to Rs. 10·48 lakhs representing 31·1 per cent as against 28·7 per cent in 1938 of the total amount outstanding at the beginning of the year. Payments of interest on loans to societies amounted to Rs. 2·46 lakhs as against Rs. 2·09 lakhs in the previous year. The total amount outstanding against societies at the end of the year was Rs. 34·97 lakhs of which Rs. 2·30 lakhs were reported as overdue arrears. The percentage of overdue arrears to total outstanding fell from 65·8 to 65·7.

Consolidation of holdings and cooperative sale of agricultural produce

The Royal Commission on Agriculture in India, in paras. 124-127 of their report, referred to the evils of fragmentation of agricultural holdings and described the attempts that were being made at consolidation in the Pnnjab and the Central Provinces. They recommended the adoption of suitable measures for combating the evil of fragmentation in all parts of the country. Consolidation of holdings is being carried out in provinces like the Punjab on a cooperative basis. It is proposed here to review briefly the progress made in the different provinces and states in this regard during 1938-39.

Conspicuous work in connection with the consolidation of holdings is being done in the Punjab. During the year 192 societies with a membership of 25,241, organized for this purpose, were registered. The total number of registered societies at the end of the year was 1,477, and work was going on in 297 villages. During the year, 157,211 acres in 217,772 blocks were consolidated into 31,687 blocks and the area consolidated thus beat the record figure of 132,313 of the previous year. The total area consolidated np to 31 July 1939 was 1,076,034 acres. The staff has been substantially increased to 30 inspectors and 279 sub-inspectors and it is paid partly by the provincial Government

partly from the Government of India grant and partly out of contributions from villagers. The cost per acre, including contributions, was Rs. 1-8-6 per acre as against Rs. 1-2-1 in the preceding year. A number of complaints were received about malpractices and in the majority of cases, they were found to be frivolous or false. Every effort is being made to put down corruption and irregularity. Consolidation work is now being done on new lines with provisions for circular roads, sites for playgrounds and schools, manure pits and proper roads.

Consolidation work could not be started in Madras in the course of the year for want of trained staff. Proposals were submitted for a special staff of inspectors for all the districts. Government, however, ordered that a start should be made in a few districts to begin with and set aside a sum of Rs. 50,000 out of the Government of India grant for village uplift to meet the cost of the special inspectors. Six districts were selected for the experiment. An honorary organizer of consolidation of holdings societies was appointed and his appointment was terminated when a special staff of supervisors was provided. There were 16 societies on 30 June 1939, and from the experience gained it was realized that no substantial progress in consolidation was possible unless arrangements could be made to effect the transfer of registry of the members' holdings in the revenue records. Special measures were proposed to overcome the difficulties involved in this procedure. Progress with regard to consolidation is slow since in this new cooperative enterprise patient and persistent propaganda among ryots is necessary.

Work in connection with consolidation made some progress in the North-West Frontier Province where activities were going on in 18 villages during the year. These new societies with a membership of 60 were registered during the year, 2,722 acres in 6,222 blocks were consolidated into 1,974 blocks. The total area consolidated so far was 34,546 acres of which 29,129 acres were in the northern circle.

The demand for consolidation is steadily increasing as its utility is coming to be recognized more widely.

In Baroda there were 77 societies and two new ones were registered during the year. The 79 societies were, however, more or less dormant during the year.

The number of consolidation societies in Delhi Province was 31, eight new societies having been registered during the year. The number of members of the societies is 2,797 and the area repartitioned is 22,325 acres. The number of blocks has been reduced from 6,412 to 1,897. No contributions were demanded from villagers and the entire cost was met by Government. The cost worked at Rs. 1-6-9 per acre as against Rs. 2-12-0 in the previous year. Area under vegetables and improved crops has considerably increased in these villages. Dehat Sudhar work has been done there and spaces have been provided for various public amenities.

The number of consolidation societies in the United Provinces rose from 118 to 147 during the year and 12,075 *bighas* were consolidated. The number of plots before the operations started was 12,822 and was reduced to 1,672 after consolidation. The total area so far consolidated is 67,000 *bighas*, number of plots having been reduced from 75,965 to 7,599.

The Royal Commission on Agriculture in India, in para. 147 of their report, recommended that in order that demonstrations of agricultural improvement may prove substantially useful, the work in that connection should be carried out through the agency of cooperative institutions, as far as possible. The Commission likewise desired, in paras. 340-342 of their report, that cooperative organization should be utilized to bring about improved quality in agricultural produce, through cooperative sale societies. Work along these lines is being attempted in several provinces and states, and a brief account of efforts in this direction is given below. Passing reference to this subject will be found in appropriate places in the review of the progress of the cooperative movement.

In MADRAS, work along these lines is being carried on by milk supply unions and societies, sugarcane growers' societies, fruit growers' societies and agricultural improvement and agricultural demonstration societies. Of the 39 societies of the last-mentioned class, only seven did active work during the year. Two societies in Tanjore distributed improved varieties of seeds, manure, etc. and the third specialized in fruit culture and in experiments in sericulture. The society in North Arcot attempted a scheme of seed-multiplication on five acres of land. The society in Cuddapah purchased manure worth Rs. 301 and distributed it among members. The Katekar Society in South Kanara distributed to 77 members new varieties of seeds for Rs. 165. It owns a plot to demonstrate the use of new varieties. The society in Trichinopoly maintained two propagandists and supplied seeds and manure worth Rs. 1·34 lakhs. The Central Bank gave it a subsidy to meet godown rent, etc. For purposes of demonstration, the society purchased lands for Rs. 21,250. Improved methods of cultivation of paddy and sugarcane were demonstrated during the year and it is believed that in respect of paddy, the improved methods resulted in an increase of Rs. 17 in the yield per acre.

Out of the 15 sugarcane growers' societies and unions some purchased seed, manure and implements with the subsidy received by them under the scheme sanctioned by Government for utilizing the sugar excise fund. The societies conducted demonstration work and propaganda with the assistance of the staff appointed under the scheme. The milk supply societies had in all 1,613 members and a paid-up share capital of Rs. 12,692. It is expected that these societies are likely to evolve into satisfactory dairies and lead to an improvement in the breed of cattle.

In BOMBAY, the number of cotton sale societies increased from 29 to 34 during 1938-39. The quantity of cotton sold increased from 5·74 lakhs of maunds to 6·56 lakhs of maunds. Among other societies of this type there was one for the sale of *gul* and tobacco each, two each for chilly and mangoes, six for the sale of fruits and vegetables, two for eggs, two for arecanut and one for paddy. There were 19 cattle breeding societies and eight dairy societies. The total membership of the latter was 991 and the number of cattle owned by them was 983. The quantity of milk supplied by members during the year was 6 lakhs of lb. and its value was Rs. 53,549. The West Khandesh purchase and sale union continued to make satisfactory progress. The union deals in all kinds of agricultural produce and its total turnover during the year amounted to Rs. 3·47 lakhs. In the new scheme of agricultural finance and marketing the sale society or union is expected to play an important part and instructions were issued during the year for reorganizing and strengthening the

position of these bodies to make them fit for the work lying ahead. The number of taluka development associations, whose primary object is to promote the introduction of improved methods of agriculture, was 104 with 24,582 individual members and 696 society members. It was felt that a taluka is too large an area for the efficient operation of these associations and it is proposed to start better farming societies whenever there is a demand for similar bodies.

In the PUNJAB, there were 183 better farming, 26 fruit plantation and 63 land reclamation societies. Better farming societies were engaged almost exclusively in the work of distribution and cultivation of improved seed. These societies distributed 2,794 mds. of wheat, 695 mds. of cotton, 80 mds. of berseem and other seeds. They also sold a few improved implements. The work of fruit plantation is increasing and nearly 5,000 plants were planted in 1938-39. There is a fruit development board at Lahore, which is the central organization: it is doing a good deal of propaganda and other work. There are nine beekeeping societies. A large number of non-official cooperators and a few sub-inspectors have been trained at the classes held by the Agricultural Department. There were 65 land reclamation societies in Hoshiarpur and Ambala and their work was done by the special staff appointed from the Government of India grant. During the year 51 societies were started. There were 20 commission shops, two sale societies, one sale union and two marketing organizations. The Egg Grading Association, Rawalpindi has 25 members, and 89,247 eggs worth Rs. 2,352 belonging to non-members were sold during the year. A ghee society was started with 55 members and 60 mds. of ghee worth Rs. 2,266 were sold during the year.

In the UNITED PROVINCES, 1,114 societies enforced better farming. Acreage under cultivation of improved wheat in these societies was over 1·11 lakhs, over one lakh under improved sugarcane and about 31,000 under other improved crops. In these societies 5,323 Meston ploughs, over 2,000 chaff-cutters, 10,400 three-roller sugar mills and about 1,100 other improved implements were introduced. The condition of the cotton production and sale society, Bilgram was unsatisfactory. Fruit cultivation societies likewise did not fare well. The Bansamati Rice Society did well and had the benefit of the services of a grader given to it under the Government of India scheme. There were two central milk supply societies, one of which functioned properly. There were also two dairies. The Lucknow Union had eight registered and 27 unregistered societies affiliated to it. It handled 4·53 lakhs lb. of milk during the year as against 1·41 lakhs lb. in the preceding year. The number of ghee societies increased from 277 to 392 in the course of the year. In addition to these, there were five central ghee unions in existence. The number of cane supply societies increased to 42 central and 681 primary societies as against 28 and 477 respectively in the previous year. The membership of the societies consisted of 3·71 lakhs of persons. One central and 14 primary societies for cattle breeding worked during the year.

In BIHAR, only 31 out of 53 central banks and unions interested themselves in agricultural improvements in their areas. *Kamdars* were appointed by four unions for popularizing improved methods of cultivation in society villages by distributing improved seeds, agricultural implements and manures as advised by the Department of Agriculture from time to time. A number of useful demonstrations in the cultivation of different varieties of crops were

carried on by other banks with the assistance of overseers and *kamdars* of the Agricultural Department. Improved varieties of seeds and chemical manures were distributed and improved implements were lent to members of societies. The Department made a free distribution of 21 mds. 35 srs. of Pusa peas, S-29, among banks and societies. These peas have gained much popularity among members as affording them a profitable ancillary occupation. The cost was met out of the Development Fund at the disposal of the Registrar. Loans were granted by a few banks and unions to societies for the promotion of land improvement. During the crushing season 1938-39, 372 cane growers' societies and 12 marketing unions with 7,782 members supplied 13·69 lakhs of maunds of cane. Due attention was paid to the introduction and propagation of improved varieties of sugarcane and agricultural implements which are gaining popularity among cane-growers. Cultivators are becoming more and more conscious of the utility of seeds of improved varieties, for which there is an increasing demand.

The activities of central banks in ORISSA in the matter of assistance for agricultural improvement in their areas were curtailed owing to financial difficulties. Only a few banks continued to maintain agricultural *kamdars* who helped the members of societies in growing English vegetables, tobacco, cotton and potatoes. Two sugarcane-growers' societies were started during the year with the help of subsidies from the sugar excise fund. One of them made a very good start. It acted as an agent of Imperial Chemical Industries, Ltd., and supplied manures worth Rs. 3,326 to its members. The Indian Central Jute Committee sanctioned a subsidy of Rs. 2,100 for cooperative marketing of jute in North Orissa.

Ten of the societies concerned in agricultural role and supply in SIND had become defunct and did no business during the year. Out of the five sale societies, the Shikarpur grain sale society maintained its record of good work. The greatest obstacles in the working of sale societies appeared to be lax management and want of loyalty on the part of members.

In BARODA, activities connected with the introduction of better kinds and new varieties of seeds were continued and increased use of artificial manures was encouraged. The pure seed supply societies were not able to work during the year. They will be liquidated gradually as it is felt that it will be more feasible to undertake their work through the agency of financing institutions and village credit societies which should be able to cater for all the needs of their members. In order to better the marketing of cotton and ensuring purity of seed in Dobhoi and Sankheda talukas, seven new societies were organized to distribute S D 8 cotton seeds to their members. The existing societies also took up this work and 152 farmers have sowed 20,900 lb. of this seed in 5,644 *bighas* of land. The farmers are given crop loans and are required to sell their cotton through the Agricultural Department. The organized effort of proper sale of 1027 A L F in the Navasari district, through the marketing officer appointed at Surat by the Agricultural Department, was continued during the year with encouraging results. There were 18 cotton sale societies at the beginning of the year. During the year 12 new societies were registered and the work of joint sale of cotton was newly introduced in the Baroda district. Besides these societies specially organized for joint sale of cotton, a number of ordinary village credit societies were induced to undertake the joint

sale of their cotton. The sale societies did good work having sold cotton worth Rs. 7·08 lakhs as against Rs. 4·39 lakhs in the preceding year. At the beginning of the year, there were 11 power pump and water works societies. Of these, one was cancelled during the year and 8 out of the remaining ten worked well. These societies irrigated 437 *bighas* of land at rates varying from As. 8 to Rs. 1-8.

In TRAVANCORE, a few officers of the Agricultural Department worked in coordination with the officers of the Cooperative Department. The Agricultural Divisional Officer,Trivandrum gave expert advice to the Dairy Cooperative Societies at Trivandrum. Ten societies were engaged in agricultural nemonstrations of varying kinds. The Eraviperoor Karshaka Cooperative Society continued its demonstrations of improved methods of sugarcane cultivation and the manufacture of *gur*. Another society was engaged in the manufacture and sale of compost manure under instructions from the local agricultural officer. There were four dairying and three cattle-breeding societies at the end of the year. Of these, only two dairy societies and one cattle-breeding society had started regular work. Of the three poultry societies at the end of the year, the Marthandam Y. M. C. A. society did the largest volume of business. The society induced its members to rear improved varieties of poultry and afforded facilities for the purpose. Attention was also paid to the preliminaries connected with the marketing of eggs, such as proper testing, grading and good packing.

In MYSORE, the Maradihalli Cooperative Society is a typical seed-growers' association. It supplied to its members during the year 500 mds. of selection 69 cotton seeds and 50 mds. of H 190 cotton seeds. It collected 13,202 mds. of seed cotton and 141 mds. of lint cotton and got them ginned and sold 254 bales of cotton. The Department of Agriculture took 6,658 mds. of cotton seed. The members realized better prices for their cotton than they could have got locally, *viz.* 2 as. per maund in respect of selection 69 and 6 as. in respect of H 190. Four credit societies in the neighbourhood availed themselves of the facilities afforded by the Maradihalli society, the quantity handled by them being 124 mds. of cotton and 106 mds. of cotton lint. Besides benefiting members by securing better prices for them, the society earned a net profit of Rs. 120 in this business. Two other societies have undertaken this work and the total quantity of improved cotton seeds sold through the societies was 2,300 mds.

CHAPTER XIV

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS

Central Government publications

THE Imperial Council of Agricultural Research continued the publication of the three Journals, viz. *Agriculture and Livestock in India* (bimonthly), the *Indian Journal of Agricultural Science* (bimonthly) and the *Indian Journal of Veterinary Science and Animal Husbandry* (quarterly), all of which reached their ninth year of life during the year. In addition to the three Journals, the following publications were issued—

(a) *Scientific Monograph No. 12.*—The Fungi of India, Supplement I, by B. B. Mundkur

(b) *Miscellaneous Bulletins*

No. 18. Milk Records of Cattle in Approved Dairy Farms in India, by K. P. R. Kartha

No. 19. A Preliminary Annotated List of the Fruit Pests of the North-West Frontier Province, by Hem Singh Pruthi and H. N. Batra

No. 20. Report on an Enquiry into the Cultivation of Cloves in India, by A. K. Yegna Narayana Iyer

No. 21. Investigations on the Cold Storage of Mangoes, by G. S. Cheema, D. V. Karmarkar and B. M. Joshi

No. 22. Report on a Village Enquiry regarding Cattle and the Production and Consumption of Milk in Seven Breeding Tracts of India

No. 23. The Cold Storage of Fruits and Vegetables, by G. S. Cheema and D. V. Karmarkar

No. 24. A Brief Survey of some of the Important Breeds of Cattle in India, Part II. Prize Winners at the first All-India Cattle Show.

No. 25. The Nutritive Values of Indian Cattle Foods and the Feeding of Animals, by K. C. Sen

No. 26. The Progress of Agricultural Science in India during the past Twenty-five Years, by W. Burns

No. 27. Definition of Characteristics of Seven Breeds of Cattle of All-India Importance

No. 28. Bibliography of Soil Erosion, by R. M. Gorrie

No. 29. Report on the Prospects of Cinchona Cultivation in India, by A. Wilson and T. J. Mirchandani

(c) Agriculture and Animal Husbandry in India, 1936-37

(d) *Marketing Series* (*Agricultural Marketing in India*)

A.M.A. 4-6. Report on the Marketing of wheat in India (Abridged in English, Hindi and Urdu).

A.M.A. 7. Annual Report of the Agricultural Marketing Adviser and summarized Reports of the Senior Marketing officers in Provinces and certain States for the year ending 31st December 1937.

A.M.A. 8. Report on the Marketing of Linseed in India

A.M.A. 9. Report on the Marketing of Eggs in India and Burma

(e) *Miscellaneous*—Report on the Cost of Production of Crops in the principal Sugarcane and Cotton Tracts in India, Vols. I to VI

Three Miscellaneous Bulletins, one Scientific Monograph and one Catalogue of Indian Insects were in the press at the end of the year.

Provincial and State Publications

In MADRAS, the Department of Agriculture issued 16 leaflets, 4 pamphlets, 8 Broad hints and 22 press notes on various subjects of practical interest in English and local languages. Three priced publications on the 'Marketing of Wheat in the Madras Province', 'Hints on Beekeeping' and the 'Cultivation of Citrus in the Northern Circars' were also issued. The Villagers' Calendar was, as usual, published. The *Madras Agricultural Journal,* issued monthly by the Madras Agricultural Students' Union, continued to be popular.

In BOMBAY, the *Poona Agricultural College Magazine* was, as usual, issued quarterly. The Deccan Agricultural Association published its monthly Marathi magazine, the *Shetki and Shetkari.*

In BENGAL seven new leaflets were published by the Department of Agriculture. The total number of leaflets and bulletins on different subjects in English and Bengali issued by the Department has risen to 79. These leaflets were very popular and 2 lakhs of copies were distributed. During the close of the year the Department started the publication of a bimonthly journal *Krishi Katha* in Bengali

In the UNITED PROVINCES, the departmental magazines *Kisan Upkark* (Hindi) and *Mufid-ul-Mazarain* (Urdu) continued to be published. The *monthly journal of the U. P. Fruit Development Board* was continued. It contains English, Urdu and Hindi Sections. The Allahabad Farmer, published by the Allahabad Agricultural Institute, appeared bimonthly.

The PUNJAB Department of Agriculture continued to issue half-yearly *Seasonal Notes.* The *Lyallpur Agricultural College Magazine* completed the sixth year of its existence. The *Punjab Fruit Journal,* issued in English and Urdu by the Punjab Fruit Development Board, continued to be popular. The *Punjab Veterinary Journal,* issued monthly in English and Urdu by the Punjab Veterinary Association, continued to be published.

In BIHAR, the Provincial Agricultural Association continued the publication of its quarterly Hindi Journal *Kisan*

In the CENTRAL PROVINCES AND BERAR, the *Nagpur Agricultural College Magazine* continued to appear quarterly.

The ASSAM Department of Agriculture issued 19 leaflets, two bulletins and three other papers on agricultural subjects.

The Department of Agriculture, SIND issued four leaflets and 31 press notes on agricultural subjects. It also issued three bulletins dealing with livestock problems. The publications cover a wide field and are usually issued in English and Sindhi.

The *Quarterly Notes,* issued by the Agriculture Department, NORTH-WEST FRONTIER PROVINCE continued to be published.

In BALUCHISTAN, the Department of Agriculture issued seven papers and four popular leaflets during the year.

In HYDERABAD, two new leaflets were published during the year and these were distributed free in large numbers. The Hyderabad Farming Association continued to issue its quarterly magazine *Hyderabad Farmer*.

The English quarterly and the Kannada monthly published by the Agricultural and Experimental Union, MYSORE continued to be popular.

A bulletin on the Soil Survey of the Shertalai taluk and five leaflets on agriculture and animal husbandry subjects were issued by the Department of Agriculture and Fisheries, TRAVANCORE.

The Department of Agriculture, COCHIN issued three papers dealing with insect pests and one paper on derris cultivation in the State.

CHAPTER XV

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS

THE financial aspects of the Agricultural and Veterinary Departments of the central, provincial and state Governments during 1938-39 are summarized in Statements I and II. Statements III-A and III-B show the figures analysed under various sub-heads.

The total gross expenditure of the central and provincial Departments of Agriculture has risen from Rs. 152·06 lakhs in 1937-38 to Rs. 152·63 lakhs in 1938-39. The total gross expenditure of the central and provincial Veterinary Departments has increased from Rs. 64·78 lakhs in 1937-38 to Rs. 69·08 lakhs. There is thus a rise of Rs. 4·87 lakhs in the total expenditure of the Agriculture and Veterinary Departments during the year.

STATEMENT I

Receipts and expenditure of the Agricultural Departments in India for 1937-38 and 1938-39.

Central Institute, Province or State	1937-38		1938-39	
	Receipts	Expenditure	Receipts	Expenditure
	BRITISH INDIA			
Imperial Agricultural Research Institute, New Delhi.	73,217	7,38,037	81,503	7,41,848
Madras	3,54,945	22,36,769	3,00,728	20,62,310
Bombay	2,03,141	14,95,657	2,06,749	16,12,187
Bengal	76,700	9,47,700	65,803	12,52,659
United Provinces	4,20,017*	25,80,918*	3,68,679	23,79,533
Punjab	12,25,308	35,64,265*	11,93,721	36,52,409
Bihar	1,29,429	8,68,519	1,32,491	9,55,653
Central Provinces and Berar	2,26,616*	10,93,114*	2,42,604	10,98,958
Assam	66,420	4,97,815	62,774	2,52,736
North-West Frontier Province	81,722	2,18,056	1,37,503	2,15,479
Orissa	23,094	1,60,940	23,916	2,22,029
Sind	1,19,720*	7,31,304*	1,31,192	7,40,365
Baluchistan	5,970	53,541*	5,099	53,799
Coorg	1,932	11,955	2,000	15,100
Ajmer-Merwara	11,779	7,327	6,689	7,891
TOTAL FOR BRITISH INDIA	30,20,010	1,52,05,817	29,51,456	1,52,62,962
	INDIAN STATES			
Hyderabad	27,080*	10,26,187*	35,007	11,44,050
Mysore	63,263	7,95,370	58,398†	8,10,619
Baroda	47,188	4,75,017	52,058	5,81,033
Travancore	8,217	1,34,085	20,195	1,91,506
Cochin	28,978	1,12,923	23,043	1,10,789
Bhopal	7,221	47,852	..	..
Jammu and Kashmir	*70,000**	*1,34,200**	*70,000*	*1,60,200*
TOTAL FOR INDIAN STATES	2,51,947	27,25,634	2,67,701	29,98,197
TOTAL FOR BRITISH INDIA AND INDIAN STATES	32,71,957	1,79,31,451	32,10,157	1,82,61,159

* Revised figures. † Provisional.

STATEMENT II

Receipts and expenditure of the Civil Veterinary Departments in India for 1937-38 and 1938-39.

Central Institute, Province or State	1937-38		1938-39	
	Receipts	Expenditure	Receipts	Expenditure
BRITISH INDIA				
Imperial Veterinary Research Institute, *Mukteswar & Izatnagar.*	5,13,320	8,22,673	5,41,024	6,52,423
Wellington Milk Depot, Wellington	42,124	39,801	39,432	36,856
Imperial Dairy Institute, Bangalore	74,404	1,34,583	72,734	1,30,512
Madras	94,013	12,41,814	1,02,406	12,85,294
Bombay	34,688	5,36,721	41,271	5,83,517
Bengal	1,46,688	4,28,254	1,57,358	4,15,814
United Provinces	1,33,347	4,36,118	1,40,414	5,06,115
Punjab	2,03,801	14,58,377*	2,42,073	17,57,278
Bihar	1,87,522	4,45,887	1,90,393	4,34,593
Central Provinces and Berar	34,148	1,65,055*	56,625	1,70,706
Assam	39,873*	1,91,677	27,068	3,37,748
North-West Frontier Province	8,500*	2,40,750*	12,366	2,56,890
Orissa	25,191	1,03,101	21,533	1,01,264
Sind	21,405	1,39,894	23,784	1,71,874
Baluchistan	60,063	60,063	51,950	51,950
Coorg	65	22,609	83	23,572
Ajmer-Merwara	1,141	10,467	1,139	9,594
TOTAL FOR BRITISH INDIA	16,20,302	64,77,844	17,22,233	69,08,000
INDIAN STATES				
Hyderabad	17,680*	4,82,724	11,099	5,33,140
Mysore	44,111	4,22,540	38,349	4,15,589
Baroda	11,873*	1,46,122*	10,026	1,56,426
Bhopal	..	15,898*	..	13,824
Jammu and Kashmir	279	78,587	398	1,01,469
TOTAL FOR INDIAN STATES	73,943	[illegible]	50,672	12,20,4[illegible]7
TOTAL FOR BRITISH INDIA AND INDIAN STATES.	16,94,245	70,23,715	17,82,1[illegible]5	81,28,457

* Revised figures.

STATEMENT III-A

Receipts and Expenditure of Agricultural Departments in India during 1937-38 and 1938-39 (Classified).

—	EXPENDITURE.									
	Crops and soils		Education (a)		Animal husbandry (b)		Miscellaneous		Total	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India										
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Imperial Agricultural Research Institute, New Delhi and its Sub-Stations.	6,53,779	6,56,592	*	*	84,258	85,256	..	..	7,38,037	7,41,848
Madras	9,01,829	8,74,953	1,49,439	1,44,535	1,38,820	8,937	10,43,672	10,39,891	22,30,760	20,62,316
Bombay	9,52,027	10,44,098	3,25,684	3,41,910	1,89,646	1,87,559	28,300	38,020	14,95,657	16,12,187
Bengal	5,29,700	6,18,267	12,500	39,246	80,200	92,834	3,26,400	5,02,312	9,47,700	12,52,659
United Provinces	†	†	3,63,212	3,81,209	1,66,022	1,58,321	@20,51,084	18,30,053	‡26,69,775	25,15,825
Punjab	@3,111,481	31,77,329	2,09,977	2,23,213	10,738	14,639	@2,32,069	2,37,228	35,64,265	36,52,409
Bihar	8,68,519	9,55,653	..	..	..	..	..	..	8,68,519	9,55,653
Central Provinces and Berar	9,00,905	8,72,296	1,21,455	1,22,727	@70,754	1,03,935	..	..	10,05,114	10,98,958
Assam	3,80,126	36,088	11,707	6,157	1,05,982	1,30,937	..	80,154	4,97,815	2,52,736
North-West Frontier Province	77,781	77,293	2,150	11,137	..	..	1,38,125	1,27,049	2,18,056	2,15,479
Orissa	1,36,816	1,75,390	..	9,932	2,232	3,100	21,792	33,007	1,60,840	2,22,029
Sind	@3,12,361	3,01,709	2,339	1,478	@43,017	42,424	@3,73,587	3,34,754	@7,31,304	7,40,365
Baluchistan	@53,541	53,799	..	..	..	..	..	..	@53,541	53,799
Ajmer-Merwara	5,431	5,392	1,896	2,499	..	..	..	..	7,327	7,891
Coorg	5,758	5,670	375	500	..	..	5,822	9,030	11,955	15,100
Indian States										
Hyderabad	@8,72,503	9,88,380	@26,210	26,210	@3,680	3,680	@1,23,704	1,25,780	10,26,187	11,44,050
Mysore	4,10,474	4,06,793	28,424	26,431	3,37,650	3,59,960	18,822	17,435	7,95,370	8,10,619
Baroda	2,21,387	2,22,894	10,968	9,051	1,00,754	1,18,559	1,35,908	2,39,579	4,75,017	5,81,033
Travancore	89,229	..	8,704	..	30,152	..	..	..	1,34,085	..
Cochin	1,07,167	21,207	..	6,902	5,756	1,011	..	82,419	1,12,923	1,10,789
Jammu and Kashmir	..	..	..	..	..	..	..	..	1,34,200	1,60,200

* As the research and education activities are combined, it is not possible to separate the figures for education.
† Not available.
@ Revised figures.
‡ This does not include expenditure on rural uplift schemes.
(a) Includes Rs. 21,190 receipts from education.
(b) As actuals for 1938-39 under XXI Agriculture-Revenue are not available, only figures of the revised estimates are entered. The figures under Animal Husbandry include, Civil Veterinary Department, Livestock Department, Serum Institute and Cattle Breeding Stations.

STATEMENT III-A—*contd.*

Receipts and Expenditure of Agricultural Departments in India during 1937-38 and 1938-39 (Classified)—contd.

	Receipts.							
	Crops and soils.		Animal husbandry (c)		Miscellaneous.		Total.	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India.								
	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Imperial Agricultural Research Institute, New Delhi and its Sub-stations.	31,292	40,990	34,400	33,218	7,525	7,300	73,217	81,508
Madras	2,47,541	2,01,523	16,881	..	90,523	99,205	3,54,945	3,00,728
Bombay	1,10,308	1,14,518	68,987	60,311	23,786	22,920	2,03,141	2,06,749
Bengal	62,260	51,900	7,140	6,750	7,300	7,153	76,700	65,803
United Provinces	†	†	@62,065	58,050	@3,57,952	3,10,629	4,24,810	4,78,591
Punjab	10,70,167	10,98,772	734	1,159	1,54,407	1,43,796	12,25,308	11,89,721
Bihar	1,29,429	1,32,491	..	..	..	..	1,29,429	1,32,491
Central Provinces and Berar	1,91,028	@2,07,985	@26,270	27,842	9,314	6,777	2,26,616	2,42,604
Assam	41,179	20,485	25,241	26,002	..	16,287	66,420	62,774
North-West Frontier Province	50,320	48,929	..	..	31,402	88,574	81,722	1,37,503
Orissa	21,357	21,700	1,737	1,849	..	307	23,094	23,916
Sind	@27,543	22,345	@2,319	2,734	@89,858	1,06,113	@1,19,720	1,31,192
Baluchistan	5,970	5,099	..	..	..	..	5,970	5,099
Ajmer-Merwara	9,883	4,190	..	..	1,896	2,499	11,779	6,689
Coorg	400	700	..	..	1,532	1,300	1,932	2,000
Indian States.								
Hyderabad	@26,550	..	@530	..	..	35,007	27,080	35,007
Mysore	26,265	27,398	30,998	¶31,000	..	..	63,263	58,398
Baroda	18,996	22,253	19,288	17,693	8,905	12,111	47,188	52,059
Travancore	7,848	..	369	..	..	..	8,217	..
Cochin	23,502	2,517	5,476	555	..	971	28,978	23,043
Jammu and Kashmir	..	..	..	..	..	..	70,000	70,000

†Not available.
@ Revised figures.
¶ Mysore Serum Institute, Hebbal, Bangalore.

STATEMENT III-B

Receipts and Expenditure of Veterinary Departments in India during 1937-38 and 1938-39 (Classified).

—	EXPENDITURE.									
	Disease Control 1		Education 2		Livestock Improvement 3		Miscellaneous 4		Total 5	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India										
Imperial Veterinary Research Institute, Mukteswar.	..	..	..	..	..	..	..	..	8,22,073	6,52,423
Imperial Dairy Institute, *Bangalore*	..	..	..	..	..	..	..	..	1,34,583*	1,30,512*
Wellington Milk Dept., Wellington	..	..	..	..	..	..	39,801	36,856	*39,801*	*38,858*
Madras	9,70,753	9,94,640	1,31,079	1,35,593	1,29,868	1,42,394	10,114	12,667	12,41,814	12,85,294
Bombay	4,72,774	5,00,807	63,947	62,710	..	..	..	..	5,38,721	5,63,517
Bengal	2,83,470	2,64,200	1,37,692	@*1,42,750*	..	..	7,092	8,765	*4,28,254*	4,15,814
United Provinces†	..	..	..	..	..	..	..	..	4,36,118	5,08,115
Punjab	@7,60,359	8,01,995	@1,66,713	1,61,147	@5,31,305	7,50,684	..	43,452	@14,58,377	17,57,278
Bihar	3,04,610	3,12,543	68,025	62,565	64,292	51,156	8,060	8,329	4,45,887	4,34,593
Central Provinces & Berar	81,704	58,808	5,358	218	77,003	1,11,680	..	..	1,65,055	1,70,706
Assam	@1,91,677	2,07,411	..	..	..	1,30,337	..	..	1,91,077	3,37,748
North-West Frontier Province	@1,52,527	1,74,155	@8,875	14,292	@70,348	68,443	..	..	2,40,750	2,56,890
Orissa	90,919	90,106	688	4,265	11,500	9,893	..	..	*1,03,101*	*1,01,204*
Sind	1,33,225	1,66,376	1,358	1,786	5,311	3,712	..	..	1,30,894	1,71,874
Baluchistan	6,886	5,290	..	..	4,481	4,280	48,606	42,380	60,063	51,950
Coorg	19,306	19,714	..	..	3,303	3,858	..	..	22,609	23,572
Ajmer-Merwara	9,482	9,594	..	..	..	..	985	1,030	10,467	9,594
Indian States										
Hyderabad	@3,36,678	3,51,606	@8,072	3,615	1,42,174	1,77,898	@9,475	10,700	4,82,724	5,39,149
Mysore	3,30,602	3,18,620	*301*	*2,426*	*91,737*	94,543	¶72,816	¶71,653	4,22,540	4,15,589
Baroda	@1,10,260	1,26,405	..	..	@35,862	30,031	..	..	1,40,122	1,56,426
Travancore	2,052	..	..	..	1,272	..	..	..	..	..
Bhopal	4,824	5,404	514	..	10,560	8,400	..	..	15,898	13,824
Jammu and Kashmir	69,502	72,742	..	..	9,085	28,726	..	..	*78,587*	*1,01,469*

*Total expenditure and recipts for the year ending 31st March 1937 and 1938 are given. *No separate figures are available under the columns 1—4.*

†Separate figures.

@Revised figures.

¶ Mysore Serum Institute, Hebbal, Bangalore.

STATEMENT III-B—*contd.*

Receipts and Expenditure of Veterinary Departments in India during 1937-38 and 1938-39 (Classified)—contd.

	RECEIPTS					
	Livestock Farms. 6		Miscellaneous (other sources). 7		Total. 8	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India.						
Imperial Veterinary Research Institute Mukteswar.	..	..	..	..	5,13,329	5,41,024
Imperial Dairy Institute, Bangalore	3,475	6,384	70,929	66,350	74,404*	72,794*
Wellington Milk Depot, Wellington	..	..	42,124	39,432	42,124	39,432
Madras	14,738	19,817	79,275	82,589	94,013	1,02,406
Bombay	..	..	34,688	41,271	34,688	41,271
Bengal	..	..	1,46,689	1,57,358	1,46,688	1,57,358
United Provinces†	..	..	..	..	1,33,347	1,40,414
Punjab	1,40,575	1,27,381	57,226	1,15,292	2,03,801	2,42,673
Bihar	62,164	53,566	1,25,358	1,36,827	1,87,522	1,90,393
Central Provinces & Berar	34,148	35,359	..	21,266	34,148	56,625
Assam	@38,798	20,002	@1,075	1,066	39,873	27,068
North-West Frontier Province	..	..	@8,500	12,366	8,500	12,366
Orissa	..	..	25,191	21,533	25,191	21,533
Sind	..	..	21,405	23,764	21,405	23,764
Baluchistan	..	..	..	..	60,063	51,950
Coorg	..	..	65	83	65	83
Ajmer-Merwara	..	..	1,141	1,139	1,141	1,139
Indian States.						
Hyderabad	@17,680	..	9,674	11,099	27,354	11,099
Mysore	4,314	5,193	39,797	¶33,156	44,111	38,349
Baroda	10,171	8,157	1,702	1,869	11,873	10,026
Travancore	128	..	..	..	..	..
Bhopal	..	..	..	..	..	..
Jammu and Kashmir	..	53	279	346	279	398

* Total expenditure and receipts for the year ending 31st March 1937 and 1938 are given. No separate figures are available under the columns 1-4.
† Separate figures.
@ Revised figures.
¶ Mysore Serum Institute, Hebbal, Bangalore.

APPENDICES

APPENDIX I

Areas under new and improved varieties of crops in India during 1938-39

Province or state	Name of crop	Area in acres					
		1937-38			1938-39		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Madras	Rice	59,408	1,711,778	1,771,186	197,519	1,506,880	1,704,399
	Wheat	..	..	..	11	40	51
	Cotton	78,735	591,967	677,702	69,275	558,059	627,334
	Sugarcane	1,646	59,868	61,414	5,319	49,197	54,516
	Millets				7,405	236,670	244,085
	Gram				..	..	..
	Potatoes	9,612	227,902	237,514	129	14,464	14,592
	Groundnut				6,095	28,916	35,011
	Other crops				2,584	6,674	9,258
Bombay	Rice	10,629	56,813	67,442	11,086	54,333	65,419
	Wheat	7,603	66,530	74,133	17,764	296,453	314,217
	Cotton	657,679	253,647	911,326	730,581	260,023	990,604
	Sugarcane	934	22,010	22,944	1,465	43,276	44,741
	Jute	..	..	..	..	..	..
	Millets	7,754	17,560	26,314	19,836	82,769	102,605
	Gram	..	..	..	75	..	75

	Potatoes	60	2,490	2,550	177	2,183	2,510
	Groundnut	510	56,487	57,006	359	52,853	53,212
	Other corps	4,545	23,954	28,499	5,135	83,358	88,493
Bengal	Rice	9,345	476,723	486,068	17,219	586,765	603,984
	Wheat	186	3,725	3,911	334	4,052	4,386
	Cotton	40	5	45	98	118	216
	Sugarcane	523	285,670	286,202	1,720	250,654	252,374
	Jute	339,202	1,424,545	1,763,747	2,922	1,568,612	1,571,534
	Millets	50	390	440	110	698	727
	Gram	258	1,149	1,407	413	1,855	2,268
	Potatoes	313	3,112	3,425	471	3,925	4,395
	Groundnut	320	1,533	1,853	1,040	1,901	2,941
	Other crops	1,178	44,903	46,081	1,476	47,149	48,625
United Provinces	Rice	20,781	205,452	226,233	64,664	247,821	312,485
	Wheat	153,311	340,904	494,215	275,021	372,852	647,873
	Cotton	10,261	26,963	37,224	13,625	16,279	29,904
	Sugarcane	23,231	766,236	789,467	56,154	928,915	985,069
	Jute	(Included under other crops.)			16	500	516
	Millets	Ditto.			1,810	6,840	8,650
	Gram	12,643	59,937	72,580	13,723	54,854	68,577
	Potatoes	(Included under other crops.)			195	172	367
	Groundnut	Ditto.			817	5,367	6,184
	Other crops	23,796	294,607	318,403	42,079	117,507	159,586

Areas under new and improved varieties of crops in India during 1938-39—contd.

Province or state	Name of crop	AREA IN ACRES					
		1937-38			1938-39		
		Depart-mental seed	Natural spread	Total	Depart-mental seed	Natural spread	Total
Punjab	Rice	22,500*	136,500*	159,000*	32,600	205,200	237,800
	Wheat	405,300*	4,532,400*	4,937,700*	381,700	4,541,200	4,922,900
	Cotton	625,000*	1,870,900*	2,495,900*	728,600	1,782,200	2,510,800
	Sugarcane	400	318,600*	319,000*	600	226,400	227,000
	Millets	800*	39,100*	39,900*	900	46,300	47,200
	Gram	14,900*	73,400*	88,300*	14,700	88,800	103,500
	Potatoes	8,600*	1,700*	10,300*	12,500	2,700	15,200
	Groundnut	150*	3,450*	3,600*	350	28,950	29,300
	Other crops	2,270*	36,950*	39,220*	3,700	46,100	49,800
Bihar	Rice	1,102	37,415	38,517	1,082	41,616	42,698
	Wheat	5,579	59,172	64,751	5,117	73,966	79,083
	Sugarcane	6,320	337,321*	343,641*	3,740	406,785	410,525
	Jute	..	2,700	2,700	..	..	..
	Gram	420*	5,915*	6,335*	844	8,141	8,985
	Groundnut	138	1,829	1,967	76	1,075	1,151
	Other crops	1,445	7,834	9,279	1,204	9,422	10,626
	Rice	..	..	702,562	..	..	781,040
	Wheat	..	..	568,415	..	..	606,819

Central Provinces and Berar	Cotton	..	..	389,773	..	..	300,380
	Sugarcane	..	..	10,026*	..	..	17,002
	Jute		..	..	..	..	..
	Millets		..	..	..	..	..
	Grams		..	..	..	..	..
	Potatoes	..	..	..	..	..	..
	Groundnut	..	..	151,466	..	..	181,[illegible]6
	Other crops	..	..	218,880	..	..	280,267
Assam	Rice	3,265	48,433	51,698	3,295	47,910	51,[illegible]9
	Sugarcane	313	15,294	15,607	302	15,147	15,440
	Jute	406	13,985	14,391	188	14,696	14,884
	Potato	296	12,008	12,304	112	12,385	12,497
Orissa	Rice	302*	24,710	25,012*	325	21,098	22,323
	Wheat	10	430	440	10	283	293
	Cotton	2	100	102	15	220	235
	Sugarcane	50	32,950	33,000	63	33,437	33,500
	Jute	5	253	258	6	418	424
	Millets	3	..	3	9	36	45
	Gram	10	390	400	9	341	350
	Potatoes	20	3,030	3,050	23	3,527	3,550
	Groundnut	25	5,987	6,012	19	5,531	5,550
	Other crops	219	14,317	14,536	262	13,499	13,761

* Revised figures.

Areas under new and improved varieties of crops in India during 1938-39—contd.

Province or state	Name of crop	Area in acres 1937-38 Departmental seed	1937-38 Natural spread	1937-38 Total	1938-39 Departmental seed	1938-39 Natural spread	1938-39 Total
North-West Frontier Province	Wheat	*29,460**	*279,086**	*308,546**	*30,266*	*408,759*	439,025
	Cotton	125	5,280	5,405	18	5,036	5,054
	Sugarcane	13,875*	18,410*	32,201*	17,870	28,367	46,237
	Gram	125	300	425	..	..	..
	Potatoes	20	3,066	3,086	10	2,806	2,816
	Groundnut	..	..	..	1	..	1
	Other crops	9,694	187,424	197,118	2,135	3,545	5,680
Sind	Rice	7,017*	589,641	596,658*	5,071	535,805	540,876
	Wheat	116,282*	536,901	652,183*	152,048	629,348	781,396
	Cotton	333,136*	1,419,710	1,752,846*	521,629	1,108,415	1,630,044
	Sugarcane	231	4,962	5,193	238	5,376	5,614
	Jute	..	484	484	..	690	690
	Millets	41	11	52	1	22	23
	Gram	153	23,344	23,497	151	15,501	14,052
	Potatoes	5	82	87	5	23	28
	Groundnut	30	..	30	..	..	..
	Other crops	10,314	102,047	112,361	22,988	152,791	175,789
	Rice	144	..	144	13	200	213
	Wheat	7,407	150	7,557	306	7,150	7,456

Baluchistan	Cotton	4,453	..	4,553	1,280	..	1,280
	Sugarcane	6	..	6	2	..	2
	Millets	34	120	154	54	120	174
	Other crops	97	..	97	16	..	16
Coorg	Rice	3	20	23	5	30	35
	Potatoes	..	..	..	..	2	2
	Groundnut	..	..	..	1	..	1
Hyderabad	Rice	551	2,071	2,622	638	5,975	6,613
	Wheat	494	1,064	1,558	885	3,578	4,463
	Cotton	239,845	8,136	247,981	142,297	45,798	188,095
	Sugarcane	419	5,017	5,436	861	14,392	15,253
	Millets	482	1,362	1,844	217	2,833	3,050
	Groundnut	5,188	169,231	174,419	3,288	195,673	198,961
	Other crops	132	571	703	127	460	587
Mysore	Rice	9,064	38,057	47,121	11,288	84,169	95,457
	Wheat	..	..	..	14	..	14
	Cotton	15,094	36,504	51,598	20,481	18,561	39,042
	Sugarcane	12,829	3,159	15,988	1,174	4,233	5,407
	Millets	4,087	159,248	168,235	5,743	199,506	205,249
	Gram	..	..	..	301	..	301
	Potatoes	..	..	..	3	421	424
	Groundnut	3,141	23,668	26,809	4,637	43,299	47,936
	Other crops	542	575	1,117	2,187	18,190	20,377

* Revised figures.

Areas under new and improved varieties of crops in India during 1938-39—concld.

Province or state	Name of crop	Area in acres 1937-38 Departmental seed	1937-38 Natural spread	1937-38 Total	1938-39 Departmental seed	1938-39 Natural spread	1938-39 Total
Baroda	Rice	573*	6,866*	7,439*	742	8,050	8,792
	Wheat	625*	8,519*	9,144*	1,083	13,292	14,375
	Cotton	41,487*	29,770*	71,257*	65,841	39,908	105,749
	Sugarcane	14	142	156	11	745	756
	Millets	50*	1,259*	1,309*	261	3,080	3,341
	Groundnut	61	5	66	38	158	196
Travancore	Rice	218	..	218	..	..	..
Cochin	Rice	112	1,436	1,548	3	531	534
	Cotton (Cambodias)	..	8,542	8,542	..	10,000	10,000
	Sugarcane	1	210	211	2	356	358
	Groundnut	..	40	40	..	75	75
	Other crops	60	133	193	75	164	239
	Rice	4	12	16	3	20	23
	Wheat	2,000	70,000	72,000	827	5,000	75,827
	Cotton	20	60	80	18	260	288

Bhopal	Sugarcane	..	..	..	15	6,800	6,815
	Millets	6	24	30	..	..	..
	Gram	1,200	2,400	3,600	78	4,000	4,078
	Groundnut	60	180	240	5	3,700	3,705
	Other crops	389	1,587	1,076	80	1,800	1,880
Jammu and Kashmir†	Rice	1,459	..	..	1,095	..	..
	Wheat	616	..	..	541	..	..
	Cotton	6	..	..	10	..	..
	Sugarcane	8	..	..	13	..	..
	Potatoes	3	..	..	3	..	..
	Other crops	1,721	..	..	1,598	..	..

*Revised figures †Natural spread not known.

APPENDIX II

List of agricultural stations in India in 1938-39

Central Institute, province, or state	Agricultural research station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Imperial Agricultural Research Institute.	New Delhi (Imperial Agricultural Research Institute Farm)	400	Assistant Agriculturist	Imperial Agriculturist	General agriculture and cattle breeding.
	Karnal (Imperial Agricultural Research Sub-station)	2,100	Farm Superintendent	Ditto	Agricultural Sub-station and Cattle Breeding Farm.
	Coimbatore	90	Farm Manager	Sugarcane Expert	Sugarcane breeding station.
	Pusa (Bihar)	200	Superintendent	Imperial Economic Botanist.	Botanical Sub-station financed by the Imperial Council of Agricultural Research.
	Guntur	20	Ditto	Ditto	Tobacco Breeding Sub-station financed by the Imperial Council of Agricultural Research.
	Simla	23	Ditto	Ditto	Potato and Wheat Breeding Sub-station financed by the Imperial Council of Agricultural Research.
	Karnal	50	Assistant	Sugarcane Expert	Sugarcane Sub-station financed by the Imperial Council of Agricultural Research.
	Samalkota (East Godavari)	57	Farm Manager	Assistant Director of Agriculture, Rajahmundry.	
	Anakapalle (Vizagapatam)	104	Superintendent	Deputy Director of Agriculture, I Circle, Coconada.	
	Maruteru (West Godavari)	50	*Assistant in Paddy*	Paddy Specialist, Coimbatore.	
	Guntur (Guntur)	150	Farm Manager	Assistant Director of Agriculture, Guntur.	
	Hagari (Bellary)	225	Superintendent	Deputy Director of Agriculture, *II Circle, Cuddapah.*	

Madras	Nandyal (Kurnool)	88	Farm Manager	Assistant Director of Agriculture, Cuddapah.
	Kodur (Cuddapah)	50	Superintendent	Deputy Director of Agriculture, II Circle, Cuddapah.
	Gudiyatham (North Arcot)	35	Farm Manager	Superintendent, Agricultural Research Station, Anakapalle.
	Kalahasti (Chittoor)	30	Ditto	Assistant Director of Agriculture, Nellore.
	Erayanur (South Arcot)	49	Superintendent	Oil Seeds Specialist, Coimbatore.
	Palur (South Arcot)	52	Farm Manager	Assistant Director of Agriculture, Cuddalore.
	Aduturai (Tanjore)	50	Ditto	Ditto.
	Pattukottai (Tanjore)	36	Assistant Director of Agriculture.	Deputy Director of Agriculture, III Circle, Trichinopoly.
	Koilpatti (Tinnevelly)	140	Farm Manager	Ditto.
	Pattambi (Malabar)	82	Assistant in Paddy	Paddy Specialist, Coimbatore.
	Taliparamba (Malabar)	86	Farm Manager	Assistant Director of Agriculture, Tellicherry.
	Kasaragod and Nileshwar (South Kanara).	178	Superintendent	Oil Seeds Specialist, Coimbatore.
	Nanjanad (The Nilgiris)	160	Farm Manager	Assistant Director of Agriculture, Coimbatore.
	Pomological Station, Coonoor, Burliar and Kallar Gardens (The Nilgiris).	30	Ditto	Curator, Government Botanic Gardens, Ootacamund.
	Central Farm, Coimbatore (Coimbatore)	400	Superintendent	Senior Lecturer in Agriculture and Superintendent Central Farm, Coimbatore.
	Buchireddipalem (Nellore)	10	Assistant in Paddy	Assistant Director of Agriculture, Nellore.
	Ambasamudram (Tinnevelly)	10	Ditto	Assistant Director of Agriculture, Tinnevelly.

List of agricultural stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural Research station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Bombay	Jalgaon (District East Khandesh)	107	Superintendent	Deputy Director of Agriculture, N. C. D., Nasik.	Cotton groundnut, *jowar* and wheat.
	Bhadgaon (District East Khandesh)	230	Ditto	*Ditto*	Cotton.
	Dhulia Agricultural School Farm (District West Khandesh).	26	*Head Master, Marachi Agricultural School, Dhulia.*	*Ditto*	*Grows the crops of the tract for teaching purposes.*
	Karjat Rice Research Station (District Kolaba).	15	District Agricultural, Overseer I/c. Rice Research Station, Karjat.	Ditto	Rice.
	Kopargaon (District Ahmednagar)	110	Superintendent	Deputy Director of Agriculture, S. C. D., Poona.	Sugarcane, cotton, groundnut and wheat.
	Ratnagiri (District Ratnagiri)	22	Ditto	Ditto	Rice, Nagli and Horticulture—mango and pineapple.
	Mohol (District Sholapur)	18	Ditto	Ditto	*Jowar.*
	Dharwar (District Dharwar)	146	Ditto	Deputy Director of Agriture, S. D., Dharwar.	Cotton, *jowar*, groundnut and miscellaneous oilseeds.
	Arbhavi (*District* Belgaum)	62	Ditto	Ditto	Sugarcane, *jowar*, maize, cotton, *tur*, khapli wheat and *horticulture.*
	Kumta (District North Kanara)	91	Ditto	Ditto	Rice, Sugarcane, Cocoanut, pineapple and *horticulture.*
	Mugad Rice Breeding Station (District Dharwar).	9	Rice Breeder	Ditto	Rice.
	Tegur Cattle Breeding Station (District Dharwar).	370	Agricultural Sub-overseer in charge, Cattle Breeding Farm, Tegur.	Ditto	Cattle breeding—Cross Amrit Mahal.
	Nipani *Tobacco* Breeding Farm (District Belgaum).	14	Tobacco Breeder	*Ditto*	Tobacco.
	Surat (District Surat)	260	Superintendent	Deputy Director of Agriculture, Gujarat, Surat.	*Jowar* and cotton.

Nadiad Tobacco Research Station (District Kaira)	22	Tobacco Breeder	Ditto	Tobacco, *bajri* and castor.
Broach (District Broach and Panch Mahals).	14	Cotton Breeder	Ditto	Cotton.
Dohad (District Broach and Panch Mahals).	68	Superintendent	Ditto	Maize in particular and wheat gram and groundnut in general.
Viramgam Cotton Breeding Station (District Ahmedabad).	33	Cotton Breeder, North Gujarat, Viramgam.	Ditto	Cotton and fodder *jowar*.
Poona Agricultural College Farm (*District Poona*).	275	Superintendent	Professor of Agriculture, Agricultural College, Poona.	Grows a large variety of Bombay Province crop for teaching purposes.
Kirkee Agricultural College Dairy (District Poona).	362	Manager	Ditto	Mainly fodder crops.
Karjat Rice Breeding Station (District Kolaba).	4	Superintendent	Crop Botanist to Government, B. P., Karjat.	Rice.
Niphad Cereal Breeding Station (District Nasik).	16	Ditto	Ditto	Wheat, millets and pulses.
Chharodi Northcote Cattle Breeding Farm (District Ahmedabad).	2,279	Manager	Livestock Expert to Government, B. P., Poona.	Cattle Breeding—Kankrej.
Bankapur Cattle Breeding Farm (District Dharwar).	249	Ditto	Ditto	Cattle Breeding—Amrit Mahal.
Kirkee Government Central Poultry Farm (District Poona).	4	Ditto	Ditto	Poultry breeding—White Leghorn, White Wyandotte, Rhode Island Red, Australarp, Asseel and Well summer.
Poona Sheep Breeding Farm (District Poona).	289	Ditto	Ditto	Sheep Breeding—Deccani and Merino.
Kirkee Ganeshkhind Fruit Experiment Station (District Poona).	80	Superintendent	Horticulturist to Government, B. P., Poona.	Mango, banana, sweet-lime, grapes, guavas, papaya, grape fruit, bor, fig, chiku, Italian lemons, etc.
Poona Modibag, Agricultural College, Poona (District Poona).	13	Ditto	Ditto	Mango, banana, *mosambi*, Navel orange, grape fruit, papaya, chiku, *Italian lemon*, *pummelo*, *kagdi* lime, guava, fig, grape vines and nursery plants of mangoes and citrus varieties.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, Province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Bengal	*Western Circle*—				
	Chinsurah Farm (Hooghly)	210	Farm Superintendent	Deputy Director of Agriculture, Western Circle.	Paddy both *aus* and *aman*.
	Berhampore Farm (Murshidabad)	44	District Agricultural Officer, Berhampore.	Ditto	Sugarcane, pulses, groundnut oilseeds, *aus* paddies, cotton.
	Suri Farm (Birbhum)	35	District Agricultural Officer, Birbhum.	Ditto	....
	Bankura Farm (Bankura)	29	District Agricultural Officer, Bankura.	Ditto	Paddy.
	Krishnagar Farm (Nadia)	46	District Agricultural Officer, Nadia.	Ditto	*Rabi* pulses, *Rahar* and Sugarcane.
	Horticultural Research Station (Nadia).	18	Horticultural Officer	Economic Botanist	Fruit trees.
	Burdwan Farm (Burdwan)	24	District Agricultural Officer, Burdwan.	Deputy Director of Agriculture, Western Circle.	....
	Jessore, Khas Mahal Farm (Jessore)	5	District Agricultural Officer, Jessore.	Ditto	Sugarcane, paddy and pulses.
	Northern Circle—				
	Rajshahi Farm (Rajshahi)	63	Farm Superintendent, Rajshahi.	Deputy Director of Agriculture, Northern Circle.	There is no special crop in any farm in this circle. Seed multiplication of improved varieties of crops is carried on in all these farms.
	Rangpur Demonstration Farm	19	District Agricultural Officer, Rangpur.	Ditto	
	Dinajpur Farm	24	District Agricultural Officer, Dinajpur.	Ditto	
	Pabna Farm	19	District Agricultural Officer, Pabna.	Ditto	
	Bogra Main Farm	28	District Agricultural Officer, Bogra.	Ditto	
	Bogra Branch Farm	7	Ditto	Ditto	

Maynaguri Farm (Jalpaiguri)	25	District Agricultural Officer, Jalpaiguri.	Ditto	
Malda Farm	16	District Agricultural Officer, Malda.	Ditto	
Eastern Circle—				
Dacca Farm (Dacca)	354	Chief Superintendent	Deputy Director of Agriculture, Eastern Circle, Bengal, Dacca.	
Comilla Farm (Tipperah)	20	District Agricultural Officer.	Ditto.	
Barisal Farm (Backergonj)	20	Ditto	Ditto.	
Charbadna Farm (Backergonj)	62	Agricultural Demonstrator	Ditto.	
Mymensingh Farm (Mymensingh)	20	District Agricultural Officer.	Ditto.	
Kishoregonj Farm (Mymensingh)	82	Agricultural Demonstrator	Ditto.	
Jamalpur Farm (Mymensingh)	34	Overseer	Ditto.	
Dhanbari Farm (Mymensingh)	6	Agricultural Demonstrator	Ditto.	
Faridpur Farm (Faridpur)	20	District Agricultural Officer.	Ditto.	
Rajbari Farm (Faridpur)	10	Agricultural Demonstrator	Ditto.	
Private Farms—Eastern Circle—				
Brahmanbaria Farm (Tipperah)	5	Ditto	District Agricultural Officer, Commilla.	
Jaidebpur Farm (Dacca)	13	Ditto	District Agricultural Officer, Dacca.	
Kalimpong Government Farm (Darjeeling).	73	Superintendent of Agriculture, Darjeeling.	Director of Agriculture, Bengal.	Maize, sugarcane, paddy, marwa, wheat, Pulses English and local vegetables, Napier grass, fruits like orange, papya, pineapple.
Rangamati Government Agricultural Farm (Chittagong Hill Tracts).	36	District Agricultural Officer, Chittagong Hill Tracts.	Ditto	Short staple cotton and terrace cultivation.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
United Provinces	*Government Sugarcane Research Station*, Shahjahanpur.	165	Economic Botanist (Sugarcane).	Economic Botanist (Sugarcane).	Chief crop : Sugarcane. Other crops : Wheat, berseem, soyabeans. The physiological work in progress at this station is financed by the Imperial Council of Agricultural Research and the Local Government. The running cost of this station is financed by the Imperial Council of Agricultural Research and the local Government.
	Rice Research Station, Nagina (District Bijnor).	77	Assistant Paddy Specialist, Nagina.	Ditto	Main crop : Paddy. Other crops : Gram, sugarcane, soyabeans.
	*Sugarcane Research Station, Muzaffarnagar.	106	Cane Agronomist, Muzaffarnagar.	Ditto (Entomological work is supervised by the Entomologist to Government, United Provinces through the Economic Botanist).	Main crop : Sugarcane. Other crops : Wheat, berseem. The agronomical and entomological investigations in progess at this station are financed by the Imperial Council of Agricultural Research.
	Sugarcane Research Sub-Station, Gorakhpur.	40	Assistant Cane Agronomist	Economic Botanist (Sugarcane).	Main crop : Sugarcane.
	Rice Research Sub-Station, Gorakhpur.	15	Junior Research Assistant	Ditto	Main crop : Paddy.
	Agricultural Farm, Kalai (Aligarh) Ratooning experiments.	20	Assistant Cane Agronomist	Ditto	Main crop : Sugarcane.
	Government Cotton Research Station, Raya (District Muttra).	154	Farm Superintendent	Economic Botanist (Cotton)	Cotton, wheat and barley.
	Instructional Farm, Cawnpore	71	Professor of Agriculture, Agricultural College, Cawnpore.	Principal, Agricultural College, Cawnpore.	This being an instructional farm for students of the Agricultural College, the crops are grown in accordance with University and Board syllabus.

Dairy Farm, Cawnpore	84	Ditto	Ditto	At this Dairy farm only the fodder crops namely maize, *jowar*, berseem, oats and Elephant grass are grown besides some gram for grain.
Instructional Farm, Agricultural School, Bulandshahr.	86	Farm Superintendent	Headmaster, Agricultural School, Bulandshahr.	Sugarcane, wheat, cotton, gram, barley, groundnut and linseed.
Government School of Agriculture, Gorakhpur.	52	Ditto	Headmaster, Agricultural School, Gorakhpur.	Sugarcane, paddy, wheat, gram, fodder crop (Elephant grass), berseem and lucerne.
Botanical Research Farm, Cawnpore	97	Ditto	Officer-in-Charge, Government Research Farm.	Researches in wheat linseed, mustard, safflower, barley, potato, castor, groundnut, cotton, *sanai*, *jowar*, maize, *til*, *bajra*, *sawan*, *mandua*, *arhar*, *urd*, *mung* and gram.
Government seed farm, Kalianpur (District Cawnpore).	258	*Ditto*	Economic Botanist (*Oil-seeds*), Cawnpore.	Sugarcane, wheat, linseed, mustard, barley, gram, peas, maize, *jowar*, *bajra*, *arhar*.
Kalai (District Aligarh)	143	Ditto	Deputy Director of Agriculture, Western Circle, Aligarh.	Wheat, cotton and sugarcane.
Bulandshahr	25	Farm Superintendent	Ditto	Ditto.
Meerut	76	Ditto	Ditto	Ditto.
Mainpuri	58	Ditto	Ditto	Wheat and groundnut.
Farrukhabad	10	Ditto	Ditto	Potato and tobacco.
Government Experimental and Research Farm, Gorakhpur.	*110*	*Ditto*	Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.	Sugarcane, wheat and paddy are the main crops.
Government Seed Demonstration Farm, Bahraich.	102	Farm Superintendent and Divisional Superintendent of Agriculture.	Deputy Director of Agriculture, Rohilkhand and Kumaun Circle, Bareilly.	Sugarcane, wheat and maize are the main crops.
Nawabganj Farm, Bareilly	120	Farm Superintendent	Ditto.	

*Has been transferred to the control of the Economic Botanist (Sugarcane) during the year under report.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks.
United Provinces—*contd.*	Kherwa Farm (Budaun)	20	Overseer-in-Charge	Deputy Director of Agriculture, Rohilkhand and Kumaun Circle, Bareilly.	
	Nigohi Model Farm (Shahjahanpur)	34	Farm Overseer	Ditto.	
	Jeolikote Hill Farm (Naini Tal)	51	Farm Overseer-in-Charge	Ditto.	
	Tarikhet Farm (Almora)	16	Ditto	Ditto.	
	Partabgarh	99	Farm Superintendent	Deputy Director of Agriculture, Eastern Circle, Partabgarh.	
	Fyzabad	206	Ditto	Ditto.	
	Benares	78	Ditto	Ditto.	
	Government Experimental Farm, Kalianpur.	258	Ditto	Deputy Director of Agriculture, Sarda Circle, Lucknow.	Wheat, sugarcane and cotton.
	District Farm, Hardoi	55	Ditto	Ditto	Wheat and sugarcane.
	Government Model Farm, Haidergarh (*District* Barabanki).	28	Ditto	Ditto	Wheat, sugarcane and paddy.
	Government Model Farm, Barabanki	30	Ditto	Ditto	Ditto.
	Government Model Farm, Unao	43	Ditto	Ditto	Ditto.
	Turner Farm, Rae Bareli	12	Ditto	Ditto	Wheat and barley.
	Government Agricultural Farm, Atarra (District Banda).	171	Ditto	Divisional Superintendent of Agriculture, Jhansi.	Sugarcane, wheat, paddy and barley.
	Government Agricultural Farm, Belatal (Hamirpur).	91	Ditto	Ditto	Wheat, sugarcane, cotton and barley.
	Government Agricultural Farm, Bichpuri (*District Agra*).	100	Ditto	Divisional Superintendent of Agriculture, Agra.	Sugarcane, wheat and barley.
	Government Agricultural Farm, Etawah.	61	Ditto	Ditto	Sugarcane, wheat, gram and barley.
	Cattle Farm, Bharari (Jhansi)	2,841	Ditto	Divisional Superintendent of Agriculture, Jhansi.	

	Cattle Farm, Madhurikund (Muttra) .	1,396	Ditto . .	Divisional Superintendent of Agriculture, Agra.	
	Cattle Farm, Manjhra Khari . .	556	Ditto . .	Deputy Director of Agriculture.	
	Cattle Farm, Hempur (Naini Tal) .	7,192	Ditto . .	Ditto.	
Punjab	*Lyallpur Agricultural Station (Lyallpur).	481	Agricultural Assistant .	Deputy Director of Agriculture, Lyallpur.	Cotton, sugarcane, wheat, *toria*, gram and fodder crops.
	Cereals Breeding Farm, Lyallpur .	35	Cerealist	Cerealist, Punjab Agricultural College, Lyallpur.	Wheat, barley, *mash (Phaseolus mungo)* and *mung* (*Phaseolus radiatus*).
	Cotton Research Station, Lyallpur .	18	Cotton Research Botanist, Lyallpur.	Cotton Research Botanist, Lyallpur.	Breeding plot for cotton.
	Cotton Research Farm, Risalewala (Lyallpur District).	230	Assistant to Cotton Research Botanist, Lyallpur.	Ditto . .	Agronomic and extensive trials with cotton.
	Cotton Research Sub-Station, Multan	25	Agricultural Assistant .	Ditto . .	Breeding and agronomic trials with cotton.
	Students' Farm, Lyallpur . . .	82	Assistant Professor of Agriculture, II.	Associate Professor of Agriculture and Professor of Agriculture, Lyallpur.	For practical training to students.
	Dairy Farm, Lyallpur . . .	36	Dairy Manager . .	Ditto . .	Fodder crops.
	Botanical Farm, Lyallpur . .	10	Professor of Botany . .	Professor of Botany, Punjab Agricultural College, Lyallpur.	Spices, drugs and economic crops.
	Fruit Farm, Lyallpur . . .	33	Agricultural Assistant .	Fruit Specialist, Lyallpur .	Experiments with fruits.
	Risalewala Farm (District Lyallpur) .	721	Ditto . . .	Deputy Director of Agriculture, Lyallpur.	Sugarcane, cotton, *toria* gram and fodder crops.
	Jhang Farm (Jhang) . . .	200	Ditto . . .	Ditto . .	Wheat, sugarcane, cotton and fodder crops.
	Rice Farm, Kala Shah Kaku (District Sheikhupura).	625	Assistant Cerealist . .	Cerealist, Punjab Agricultural College, Lyallpur.	Rice.
	Montgomery Agricultural Station (Montgomery).	681	Agricultural Assistant .	Deputy Director of Agriculture, Montgomery.	Wheat, *toria*, gram, cotton and fodder crops.
	Shergarh Farm (District Montgomery)	1,549	Ditto . .	Ditto . .	Rice, wheat, cotton, *toria*, gram, *sarson* and lucerne.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Punjab—contd.	**Fatna Farm** (District Montgomery)	528	Agricultural Assistant	Deputy Director of Agriculture, Montgomery	Wheat, *toria*, gram, cotton and fodder crops.
	Yusafwala Farm (District Montgomery)	3,137	Ditto	Ditto	Wheat, cotton, gram and *toria*.
	Multan Farm (Multan)	528	Ditto	Deputy Director of Agriculture, Multan.	Wheat, cotton, sugarcane, barley, gram, rice, berseem and *toria*.
	Vihari Farm (District Multan)	500	Ditto	Ditto	Wheat, cotton, sugarcane and berseem.
	Gurdaspur Agricultural Station (Gurdaspur).	289	Ditto	Deputy Director of Agriculture, Gurdaspur.	Sugarcane, maize, cotton, rice, wheat, gram, barley and fodder crops.
	Beas Farm (District Amritsar)	30	Ditto	Ditto	Cotton, maize, *bajra*, wheat, *toria* and fodder crops.
	Attari Farm (District Amritsar)	101	Ditto	Ditto	Sugarcane, cotton, maize, wheat, *Sar on*, gram and fodder crops.
	Gujranwala Farm (Gujranwala)	107	Ditto	Ditto	Sugarcane, cotton, rice, wheat, *toria* and fodder crops.
	Rawalpindi Agricultural Station (Rawalpindi).	252	Ditto	Deputy Director of Agriculture, Rawalpindi.	Wheat, cotton, sugarcane, groundnut and fodder crops.
	Campbellpur Farm (Campbellpur)	105	Ditto	Ditto	Wheat, groundnut, gram, *guara*.
	Gujrat Farm (Gujrat)	47	Ditto	Ditto	Wheat, cotton, sugarcane, groundnut and fodder crops.
	Chillianwala Farm (District Gujrat)	250	Ditto	Ditto	Wheat, cotton, sugarcane, *toria*, groundnut and fodder crops.
	Sargodha Old Farm (Sargodha)	155	Ditto	Ditto	Wheat, cotton, sugarcane, *toria*, gram and fodder crops.

	Sargodha New Farm (Sargodha)	492	Ditto	Ditto	Wheat, cotton, sugarcane, gram, groundnut and fodder crops.
	Mianwali Farm (Mianwali)	162	Ditto	Ditto	Wheat, *Rabi* fodder.
	Hansi Agricultural Station (District Hissar).	589	Ditto	Deputy Director of Agriculture, Hansi.	Wheat, cotton, sugarcane, rice, millets, gram, potato and *groundnut*.
	Botanical Sub-Station, Sirsa (District Hissar).	145	Millet Botanist and Fodder Specialist.	Professor of Botany, Punjab Agricultural College, Lyallpur.	*Bajra* maize, tobacco, gram and fodder crops.
	Cereals and *Oilseeds Breeding* Sub-Station, Gurgaon.	100	Agricultural Assistant	Deputy Director of Agriculture, Hansi.	Wheat, barley, pulses and oilseeds.
	Rohtak Dry Farming Research Station (Rohtak).	100	Agriculturist	Ditto	Drought resistant crops.
	Ambala Farm (Ambala)	100	Agricultural Assistant	Ditto	Wheat, cotton, sugarcane, gram and fodder crops.
	Karnal Farm (Karnal)	100	Ditto	Ditto	Wheat, cotton, sugarcane, *toria*, gram and fodder crops.
	Ludhiana Farm (Ludhiana)	54	*Ditto*	*Deputy Director of Agri*culture, Jullundur.	*Cotton*, wheat, *gram*, groundnut, *toria* and berseem.
	Kangra Agricultural Plot (Kangra)	10	Ditto	Ditto	Potatoes, maize and berseem.
	Jullundur Agricultural Station (Jullundur City).	121	Ditto	Ditto	Tobacco, wheat, sugarcane, maize, potatoes and berseem.
	Ferozepur Farm (Ferozepur)	100	Ditto	Ditto	Sugarcane, wheat, cotton, gram and berseem.
Bihar	Pusa (District Darbhanga)	1,278 out of which 665 are under cultivation.	Assistant Director of Agriculture.	Deputy Director of Agriculture, Tirhut Range, Pusa.	
	Sepaya (District Saran)	379	Farm Manager	*Ditto.*	
	Musheri	91	Overseer	Ditto.	
	Siwan (District Saran)	70	Ditto	Ditto.	
	Darbhanga (*District Darbhanga*)	26	*Ditto*	Ditto.	

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Bihar	Byresh (District Champaran)	316	Superintendent, Bettiah Estate Farms.	Deputy Director of Agriculture, Tirhut Range, Pusa.	
	Patna (District Patna)	200	Farm Manager	Deputy Director of Agriculture, Patna.	
	Gaya (District Gaya)	95	Overseer	Ditto.	
	Nawada (District Gaya)	88	Ditto	Ditto.	
	Bikramganj (District Shahabad)	24	Ditto	Ditto.	
	Siris (District Gaya)	35	Ditto	Ditto.	
	Sabour (District Bhagalpur)	150	Farm Manager	Deputy Director of Agriculture, Bhagalpur Range, Sabour.	
	Jamui (District Monghyr)	38	Overseer	Ditto.	
	Banka (District Bhagalpur)	26	Ditto	Ditto.	
	Purnea (District Purnea)	60	Ditto	Ditto.	
	Kanke (District Ranchi)	340	Farm Manager	Deputy Director of Agriculture, Chotanagpur Range, Kanke.	
	Netarhat (District Ranchi)	198	Overseer	Ditto.	
	Chianki (District Palamau)	32	Ditto	Ditto.	
	Chaibassa (District Singhbhum)	38	Ditto	Ditto.	
	Purulia	52	Ditto	Ditto.	
	Experimental Farm, Akola (District Akola).	272	Superintendent	Economic Botanist for Cotton.	Cotton, groundnut and *juar*.
	Experimental Farm, Tharsa (District Nagpur).	116	Ditto	Deputy Director of Agriculture.	Wheat and sugarcane.
	Experimental Farm, Chhindwara (District Chhindwara).	70	Ditto	Ditto	Wheat, cotton, sugarcane and fruit.
	Experimental Farm, Powerkheda (Hoshangabad).	528	Ditto	Ditto	Wheat.

Central Provinces and Berar	Experimental Farm, Adhartal (Jubbulpore).	299	Ditto . .	Ditto .	Rice, wheat and sugarcane.
	Experimental Farm, Nagpur (District Nagpur).	252	Ditto . .	Principal, Agricultural College.	Cotton, wheat and *juar*.
	Experimental Farm, Labhand (District Raipur).	229	Ditto . .	Deputy Director of Agriculture.	Rice and wheat.
	Seed and Demonstration Farm, Waraseoni, Balaghat.	63	Ditto . .	Ditto .	Sugarcane and paddy.
	Seed and Demonstration Farm, Betul (District Betul).	161	Ditto . .	Ditto .	Wheat and sugarcane.
	Seed and Demonstration Farm, Bilaspur (District Bilaspur).	253	Ditto . .	Ditto .	Rice and sugarcane.
	Seed and Demonstration Farm, Duldana (District Buldana).	137	Ditto . .	Ditto .	Cotton, *juar* and groundnut.
	Seed and Demonstration Farm, Drug	281	Ditto . .	Ditto .	Rice and sugarcane.
	Seed and Demonstration Farm, Khandwa (District Nimar).	180	Ditto . .	Ditto .	Cotton and groundnut.
	Seed and Demonstration Farm, Chankhuri (District Raipur).	320	Ditto . .	Ditto .	Rice and sugarcane.
	Seed and Demonstration Farm, Seoni, (District Chhindwara).	170	Ditto . .	Ditto .	Wheat and sugarcane.
	Seed and Demonstration Farm, Yeotmal (District Yeotmal).	106	Ditto . .	Ditto .	Cotton, groundnut and *juar*.
	Seed and Demonstration Farm, Saugor (District Saugor).	161	Ditto . .	Ditto .	Wheat.
	Seed and Demonstration Farm, Dindori (District Mandla).	510	Ditto . .	Ditto .	Rice and wheat.
	Seed and Demonstration Farm, Sindewahi (District Chanda).	213	Ditto . .	Ditto .	Rice and sugarcane.
	Seed and Demonstration Farm, Borgaon (District Akola).	379	Ditto . .	Ditto .	Cotton, groundnut and *juar*.
	Seed and Demonstration Farm, Ellichpur (District Amraoti).	300	Ditto . .	Ditto .	Cotton and *juar*.
	Seed and Demonstration Farm, Basim (District Akola).	110	Ditto . .	Ditto .	Cotton, groundnut and *juar*.
	Seed and Demonstration Farm, Damoh (District Saugor).	117	Ditto . .	Ditto .	Wheat.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Assam	Upper Shillong Experimental Station (Khasi and Jaintia Hills).	522	Farm Manager	Deputy Director of Agriculture, Livestock.	Cattle breeding, potato and fodder crop.
	Khanapara Cattle Breeding Farm (Kamrup).	208	Ditto	Ditto	Cattle breeding and fodder crops.
	Sylhet Cattle Breeding Farm (Sylhet).	228	Ditto	Ditto	Ditto.
	Jorhat Experimental Station (Sibsagar).	50	Ditto	Deputy Director of Agriculture, Upper Assam Valley and Economic Botanist, Assam.	Cattle breeding and sugarcane crop.
	Titabar Experimental Station (Sibsagar).	125	Ditto	Economic Botanist, Assam	Paddy.
	Karimganj Experimental Station (Sylhet).	80	Ditto	Deputy Director of Agriculture, Surma Valley.	Ditto.
	Habiganj Deep Water Paddy Research Farm (Sylhet).	54	Ditto	Economic Botanist, Habiganj.	Deep water paddy.
	Shillong Fruit Experimental Station (Khasi and Jaintia Hills).	63	Fruit Inspector	*Director of Agriculture*, Assam.	*Fruit.*
	Citrus Fruit Research Station, Burnihat.	20	Horticultural Assistant	Economic Botanist, Assam.	Citrus fruit.
Orissa	Cuttack Farm (District Cuttack)	150	Farm Manager	Deputy Director of Agriculture.	General Crop— Paddy and sugarcane breeding work. Flood and salt resisting paddy and *rabi* crops.
	Kujang Farm (District Cuttack)	30	Agricultural Overseer	Ditto	
	Angul Farm (District Cuttack)	47	Ditto	Ditto	Citrus cultivation.
	Aul Farm (District Cuttack)	5	Agricultural Sardar	Ditto	Flood resisting paddy and *rabi* crops.
	Balia Farm (District Balasore)	75	Agricultural Overseer	Ditto	General crop.
	Khurda Farm (District Puri)	33	Ditto	Ditto	Ditto.
	Puri Farm (District Puri)	47	Ditto	Ditto	Cocoanut cultivation.
	Sambalpur Farm (District Sambalpur)	32	Ditto	Ditto	Citrus cultivation.
	Udayagiri Farm (District Ganjam)	30	Ditto	Ditto	Vegetable cultivation.

	Pottangi Farm (District Koraput)	10	Ditto	Ditto	Fruit cultivation.
	Cuttack Rice Research Station (District Cuttack).	12	Paddy Specialist	Ditto	Paddy cultivation.
	Berhampur Rice Research Sub-station (District Ganjam).	33	Research Assistant	Deputy Director of Agriculture and Paddy Specialist.	Ditto.
	Jeypore Rice Research Sub-station (District Koraput).	15	Ditto	Ditto	Ditto.
North-West Frontier Province	Tarnab Research Station (Peshawar)	200	Farm Manager	Agricultural Officer, North-West Frontier Province.	
	Experimental Station, Serai Naurang	100	Ditto	Extra Assistant, Director of Agriculture, Southern Circle Serai Naurang.	
	Noel Garden, Dehra Ismail Khan	12	Agricultural Assistant, Dera Ismail Khan.	Ditto.	
	Lotus Farm, Mawya Killi (Bannu)	2	Agricultural Assistant, Bannu.	Ditto.	
	Experimental Farm, Haripur (Hazara)	10	Agricultural Assistant, Haripur.	Extra Assistant Director of Agriculture, Northern Circle, Haripur.	
	Ali Mangal Garden (Kurram Agency)	2	Agricultural Assistant, Parachinar.	Extra Assistant Director of Agriculture, Kurram Agency.	
	Roberts Bagh, Kurram Agency	40	Ditto	Ditto.	
	Parachinar Agricultural Farm (Kurram Agency).	115	Ditto	Ditto.	
	Mir Jamal Garden (Kurram Agency)	6	Ditto	Ditto.	
	Alizai Agricultural Farm, (Kurram Agency).	8	Ditto	Ditto.	
Sind	Agricultural Research Station Sakrand (District Nawabshah).	417	Officer in Charge, Sakrand	Director of Agriculture, Sind.	All crops except paddy. *Main crops being cotton*, wheat, *jowar*, oilseeds and garden crops.
	Agricultural Research Station, Dokri (District Larkana).	470	Officer in Charge, Dokri	Ditto	Cotton, oilseeds, cereals, fodder.
	Government Auxiliary Farm, Shahdadkote (District Larkana).	212	Manager	Deputy Director of Agriculture, Right Bank.	Cotton, wheat, oilseeds and fodder.
	Government Auxiliary Farm, Dadu (District Dadu).	585	Ditto	Ditto	Ditto.
	Government Auxiliary Farm, Nasirabad (District Larkana).	311	Ditto	Ditto	Paddy crop.

List of Agricultural Stations in India in 1938-39—contd.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Sind	Experimental Seed and Cattle Farm, Tatta (*District Karachi*).	1,026	Manager	Deputy Director of Agriculture, Right Bank.	Paddy, *jowar*, *bajri*, wheat and grasses.
	Government Auxiliary Farm, Padidan (District Nawabshah).	290	Ditto	Deputy Director of Agriturecul, Left Bank.	Cotton, wheat, *jowar*, turio.
	Government Auxiliary Farm, Lundo (District Nawabshah).	458	Ditto	Ditto	Cotton, wheat *jowar*, citrus fruits.
	Government Auxiliary Farm, Oderolal (District Hyderabad).	362	Ditto	Ditto	Cotton, wheat, *jowar*, and oilseeds.
	Government Fruit Farm, Mirpurkhas (District Thar Parkar).	60	Horticulturist	Director of Agriculture, Sind.	Fruit culture.
	Government Fruit Sub-Station, Larkana (District Larkana).	60	Manager	Horticulturist	Ditto.
	Agricultural Sub-Station, Shikarpur, District Sukkur.	20	Inspector of Agriculture, Shikarpur.	Divisional Superintendent of Agriculture, North Sind, Sukkur.	Cotton, wheat, gram.
	Jamesabad Sub-Station, District Thar Parkar.	32	District Agricultural Overseer, Jamesabad.	Inspector of Agriculture, Jamrao.	Cotton, wheat.
	Deh—257, Jamesabad, *District* Thar Parkar.	76	*Ditto*	*Ditto*	*Ditto.*
	Nawabshah Sub-Station, District Nawabshah.	16	Inspector of Agriculture, Nawabshah.	Deputy Director of Agriculture, Left Bank, Hyderabad.	Cotton, wheat and berseem.
	Government Seed Farm, Mirpurkhas, District Thar Parkar.	198	Cotton Breeder and Officer in Charge.	Director of Agriculture, Sind.	Cotton, wheat, *bajri* and green manuring. Breeding work on cotton and *bajri* is being conducted.
Baluchistan	Fruit Experiment Station, Quetta	25	Assistant Pomologist	Agricultural Officer in Baluchistan.	
	Government Seed Farm, Usta (District Sibi).	300	Agricultural Assistant	Ditto.	
Ajmer-Merwara	Tabiji Farm (Ajmer-Merwara)	12	Farm Superintendent	Assistant Commissioner	Wheat and Cotton—Managed by the District Board to whom an annual grant of Rs. 2,970 is given by the Government.
	Makrera Farm (Ajmer-Merwara)	20	Ditto	Ditto	

Coorg	**Sanivarsanthe** Paddy Experimental **Farm**, Coorg.	7	Agricultural Demonstrator, Somwarped, Coorg.	Deputy Director of Agriculture, Coorg.	*Paddy.*
	Kudige Dry Farm, Coorg	6	Ditto	Ditto	*Ragi*, groundnut, tobacco, potato and Chillies.
	Mutharmudi Paddy Experimental Farm, Coorg.	9	Agricultural Demonstrator, Mercara, Coorg.	Ditto	Paddy.
	Napokiu Farm, Coorg	8	Ditto	Ditto	*Ditto.*
	Gonikoppal Farm, Coorg	8	Agricultural Demonstrator, Gonikoppal, Coorg.	Ditto	Ditto
	Gonikoppal Orange Farm, Coorg	5	Ditto	Ditto	Orange.
	Hudikeri Paddy Farm, Coorg	7	Ditto	Ditto	Paddy.
Hyderabad (Deccan)	**Main Experimental** Farm Himayat**sagar** (District Atrafe Balda).	290	Farm Superintendent	Deputy Director of Agriculture, West Telingana, Himayatsagar.	
	Main Experimental Farm, Warangal	104	Ditto	Deputy Director of Agriculture, East Telingana, Warangal.	
	Main Experimental Farm, Raichur	116	Ditto	Deputy Director of Agriculture, Karnatic Division, Raichur.	
	Main Experimental Farm, Parbhani	265	Ditto	Deputy Director of Agriculture, Godavari Division, Parbhani.	
	Experimental Farm, Sangareddy (District Medak.)	78	Ditto	Deputy Director of Agriculture, West Telingna, Himayatsagar.	
	Experimental Farm, Sangareddy *Rudrur (District Nizamabad.)*	65	Ditto	Ditto	
	Poultry Farm, Himayatsagar (District Atrafe-Balda).	Suitable plot reserved on the Main Farm.	Fieldman and Agricultural Assistant.	*Ditto.*	
	Poultry Farm, Parbhani	Ditto.	Farm Superintendent	Deputy Director of Agriculture. Godavari Division, Parbhani.	
Mysore	Paddy Breeding Station, Nagenahalli, Mysore (District Mysore).	63	Agricultural Inspector	Assistant Director of Agriculture, Mysore.	
	Kar Ragi Breeding Station, Hunsur (District Mysore).	44	Manager	Ditto.	
	Jeevanarayankatte, Mysore (District Mysore).	2	Agricultural Inspector	Ditto	Different kinds of crops in connection with the Mysore *Dasara* Agricultural and Industrial Exhibition, for demonstration.

List of Agricultural Stations in India in 1938-39—concld.

Central Institute, province, or state	Agricultural station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
	Government Coffee Experiment Station, Balehonnur.	290	Manager	Senior Assistant Director, Chikmagalur.	Coffee, cardamom, pepper, pine apples, citrus and other fruit plants, clove and other spices, cotton, tung-oil, wattle, divi-divi, cashewnut, grasses and leguminous fodder plants.
	Irwin Canal Farm, District Mandya	650	Superintendent, Irwin Canal Farm.	Assistant Director, Mandya Circle.	Sugarcane, paddy, cotton, tobacco, groundnuts and other miscellaneous crops such as plantain, cocoanut, pineapple, *irrigated ragi*, pulses, etc.
	Experimental Farm, Marthur (District Shimoga).	116	Farm Manager	Assistant Director, Shimoga Circle.	Areca, pepper, cardamom, paddy, sugarcane, pineapple, chillies.
Mysore	Experimental Farm, Babbur (District Chitaldrug).	220	Ditto	Assistant Director	Sugarcane, cotton, tobacco, castor, *jola*, chillies, cocoanut, summer paddy, groundnut orchard.
	Singapur Kaval Farm, Chitaldrug	18	Agricultural Inspector, Chitaldrug.	Ditto	
	Yellachihalli Sheep Farm	500	Agricultural Inspector		
	Cattle Breeding Station, Ajjampur, (District Kadur).		Manager		
	Cattle Breeding Sub-Station, Basur (District Kadur).	6,020	Ditto	Live stock Expert.	
	Sheep Farm, Ajjampur, (District Kadur).		Veterinary Inspector		
	Government Experimental Farm, Hebbal, District Bangalore.	229	Principal in Charge, Hebbal Farm.	Deputy Director of Agriculture, Bangalore.	
	Agricultural Experimental Station, Baroda (District Baroda).	104	Superintendent	Deputy Director of Agriculture, Southern Circle, Baroda.	
	Agricultural Experimental Station, Dabhoi (District Baroda).	69	Ditto	Ditto.	
	Agricultural Experimental Station, Vyara (District Navsari).	28	Ditto	Ditto.	
Baroda	Agricultural Experimental Station, Vasma (District Navsari).	62	Ditto	Ditto.	

	Agricultural Experimental Station, Jagudan (District Mehsana).	50	Ditto	Deputy Director of Agriculture, Northern Circle, Mehsana.	
	Agricultural Experimental Station, Amreli (Kathiawar) (District Amreli.)	60	Ditto	Ditto.	
Travancore	Fruit Farm, Cape Comorin	16	Farm Manager	....	Fruit plants and fruits.
	Paddy Farm, Nagercoil	40	Ditto	Divisional Agricultural Officer, Trivandrum.	Paddy.
	Pepper Farm, Koni	160	*Headmaster* Agricultural School, Koni.	Director of Agriculture	Pepper.
	Demonstration Farm, Puliyara	35	Farm Manager	Divisional Agricultural Officer.	Tobacco, *cholam*, etc.
	Coconut Farm, Alleppey	9	Agricultural Demonstrator	Ditto	Coconut.
	Coconut Farm, Oachira	4	Ditto	Ditto	Ditto.
	Kari Experimental Station, Porakad	25	Field Assistant	Director of Agriculture	Only 5 acres are cultivated with paddy.
	Paddy Breeding Farm, Onattukara	5	Economic Botanist	Ditto	Selection work of paddy.
	Sugarcane Farm, Alwaye	10	Agricultural Demonstrator	Divisional *Agricultural* Officer.	*Sugarcane.*
Cochin	Government Central Farm, Ollukkara, Trichur.	418	Manager, Government Central Farm.	Director of Agriculture, Cochin.	Paddy, sugarcanes, etc.
	Government Coconut Experimental Station, Kaittila, Ernakulam.	24	Agricultural Inspector, Cochin, Kanayanur taluk.	Ditto	Cocoanuts.
Bhopal	Central Research Farm, Nabi Bagh	154	Farm Incharge	Director of Agriculture and State Chemist.	Cereals and other crops.
	Cotton Research Farm, Bhil Kheri	100	Ditto	Ditto	Cotton and other crops.
	Paddy Farm, Chiklod	10	*Ditto*	Ditto	Paddy.
	Cotton Farm, Nasrullaganj	85	Ditto	Ditto	Cotton and other crops.
	H. H.'s Farm, Sultanpur	250	Ditto	Ditto	Sugarcane.
	Sugarcane Farm, Sehore	100	Ditto	Ditto	Ditto.
Jammu and Kashmir	Partap Model Farm, Shalamar	80	Manager	Director of Agriculture	Rice, wheat, maize including sugar corie, green peas and vegetables.
	Gul Samandar Farm	28	Agricultural Assistant	Assistant Director of Agriculture, sugarcane, wheat and rice.	

APPENDIX III

Staffs of central, provincial and state departments of agriculture in India during 1938-39

Central Institute, province, or state	Research and Teaching Staff						District Staff					
	Superior Service		Provincial Service		Subordinate Service		Superior Service		Provincial Service		Subordinate Service	
	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively
British India												
Imperial Agricultural Research Institute, New Delhi.	10	8	18	16	42	41	..	..	..	..	..	..
Imperial Dairy Institute, Bangalore	..	..	2	2	6	6	..	..	..	..	..	..
Madras	3	2	22	21	103	103	5	2	16	13	257	257
Bombay	2	2	17	17	104	104	3	3	10	10	182	178
Bengal	1	1	12	11	28	18	2	2	6	6	30	27
United Provinces . . .	7	7	19*	19*	97	97†	18	12	22*	10*	821†	821
Punjab	13	13	30	30	245	245	10	9	21	21	638	686
Bihar	..	..	10	7	3	3	2	2	14	9	115	115
Central Provinces and Berar . .	2	2	7	6	26	26	3	3	13	12	118	118
Assam	..	..	4	4	19	19	..	..	3	3	98	98
North-West Frontier Province .	1	1	1	1	15	15	..	..	..	3	10	10
Sind	..	..	8	8	41	30	..	..	4	4	142	141

Orissa	..	..	1	1	10	9	..	..	2	2	35	1
Baluchistan	1	1	..	..	..	..	..	..	..	..	15	15
Ajmer-Merwara	..	..	..	..	..	..	..	..	1	..	7	2
Indian States												
Hyderabad	2	2	4	4	10	10	5	5	5	5	53	53
Mysore	..	..	17	14	77	67	..	..	19	19	122	122
Baroda	..	..	11	11	9	9	4	4	9	9	46	46
Travancore	8	8	..	..	5	5	17	17	..	..	18	18
Cochin	4	4	..	..	16	16	8	8	..	..	11	11
Bhopal	1	1	2	2	2	2	..	..	..	..	..	..
Jammu and Kashmir	1	1	..	..	4	4	1	1	4	4	29	27

* Includes the staff sanctioned by I. C. A. R. in various schemes as well as that sanctioned in connection with cane development scheme.
† Includes the staff in rural development scheme and other temporary schemes excluding cane developments.

APPENDIX IV

Results of well-boring in India during 1938-39

Province or state	1937-38		1938-39	
	Number of bores	Number successful	Number of bores	Number successful
British India				
Madras	971	673	759	612
Bengal	181	175	..	..
United Provinces	2,297	2,047	2,228	2,007
Punjab	853	286	427	348
Bihar	242	193	260	230
Central Provinces and Berar	..	..	1*	..
North-West Frontier Province	..	..	1	1
Orissa	7	7	10	7
Sind	5	2	3	1
Indian States				
Hyderabad	30	27 successful 2 failure 1 site changed due to nature of rock	28	17 successful 4 failure 7 work abandoned due to nature of rock.
Mysore	14	10	17	17
Baroda	78 and 108 Blasting	45 75	116 and 465 Blasting	66 388

* A 6" bore was drilled to a depth of 100 feet in hard trap rock at Talinkheri in the hope of striking water, the boring still continues.

APPENDIX V

Sale of improved implements through departmental agency in India during 1938-39

Province or state	Ploughs		Cane mills		Fodder cutters		Hoes		Other implements		Spare parts	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India												
Madras	3,173	6,608	119	47	0	11	105	235	1,318	1,902	5,257	6,186
Bombay	272	331	78	101	2	12	167	68	940	1,667	1,291	2,408
Bengal	275	581	10	2	1	..	6	231	20	5	4	..
United Provinces	7,174	16,887	110	73	5,447	6,160	948	1,078	3,726	3,705	25,750	22,052
Punjab	6,716	6,156	1,426	803	22,154	23,049	1,082	1,937	4,647	5,671	17,248	19,664
Bihar	634*	1,010	44	5	5	1	374*	567	505*	330	618*	2,111
Central Provinces and Berar	1,279	1,174	193	185	4	9	44	69	1,509	1,915	17,090	17,371
Assam	7	..	109	73	..	..	2	4	36	32	147	80
North-West Frontier Province	43	38	142	57	59	68	8	7	14	31	59	75
Orissa	..	2	29	20	..	..	..	1	28	11	..	..
Sind	..	..	..	..	..	..	..	..	..	..	..	..
Baluchistan	1	..	..	..	..	..	1	..	..	..	..	..
Coorg	24	24	..	..	..	..	..	1	7	8	24	..
Indian States												
Hyderabad	127	119	3	7	8	5	16	19	37	44	1,735	1,625
Mysore	1,049	1,081	14	6	..	..	..	..	139	157	2,774	2,815
Baroda	375*	490	..	..	6	3	705*	508	2,895	4,535	40*	only shares 60
Travancore	..	..	..	..	..	..	..	..	45	50	..	8
Cochin	8	7	1	..	..	..	..	2	95	45	..	..
Jammu and Kashmir	10	..	..	..	..	..	..	..	16	..	..	..

* Revised figures.

APPENDIX VI

Improved seeds and manures distributed through departmental agency in India during 1938-39

Central Institute, province, or state	SEED DISTRIBUTED						MANURES DISTRIBUTED			
	SEED GRAIN IN CWT.		NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		FRUIT PLANTS NO.		COMMERCIAL FERTILIZERS IN CWT.		OIL CAKES IN CWT.	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India										
Imperial Agricultural Research Institute and its Sub-station.	1,927	1,940	475(a)	1,356(a)	..	..	..	..	..	..
Madras	19,608	13,590	206,246 + 16,425,000(b)	21,203,512 (c)	1,332,296	121,157	..	21,437	..	14,056
Bombay	60,094	12,896	8,237,211	1,858,364	147,001	237,387	25,566	14,738	8,649	6,978
Bengal	5,211	9,150	687,480 (Canes) 1,096,550(d)	328,348 (Canes) 420,125 (d)	13,202	10,458	468	603	488	508
United Provinces	270,187	847,315	584,492	2,459,719	15,983	89,872(e)	25,885	51,884	5,717	92,895
Punjab	408,200	349,020	(f)	(g)	34,100	39,100	(d)	(d)	..	..
Bihar	7,569*	9,645	27,009	71,038	..	1,191	1,445*	1,446	8,193	6,866
Central Provinces and Berar	296,622	301,026	3,120,186	3,151,163	115,545	125,798	18,069	12,742	1,348	1,516
Assam	1,128*	2,392	74,580 sets*	91,920 sets	10,266	11,125	17	111	7*	148

North-West Frontier Province	8,020*	9,687	16,700*	15,424	6,460	23,176	105*	96	..	..
Orissa	161	60	33,000	33,128	5,538	9,428	58	48	1	2
Sind	85,705*	111,139	82 (Mds.)	235 (Mds.)	30,837	31,284	148	..	..	..
Baluchistan	139	237	..	..	7,487*	11,090	..	..	..	..
Ajmer-Merwara	150	106	..	..	..	..	..	..	..	..
Coorg	3	5	..	..	750	250	30	80	..	20
Indian States										
Hyderabad	29,163	43,816	673 cwt. (seeds)	25,869 cwt. (seeds)	8,496	6,241	1,851	3,220	271	1,644
Mysore	1,976	5,245	22,000	1,022,140	3,550	17,745	No direct sales by the department.			
Baroda	1,241*	1,635	134,843*	92,053	7,512*	7,310	1,014*	888	900*	1,255
Travancore	117	..	25,077 Setts	..	695	..	No direct sales by the department.			
Cochin	164	170	58,007	18,986	17,253	10,056	386	409	386	526
Bhopal	486 (Mds.)	905	2,106	..	300	...	310	138	20	12
Jammu and Kashmir	1,689 (Mds.)	1,287 and 667 cwts.	96 (bundles)	138 (*gandaras*)	1,37,609	1,47,666	..	..	..	..

(a) Including *200 small parcels.*
(b) Setts distributed from short crops in the Vizagapatam district.
(c) Setts.
(d) Cuttings.
(e) Increase due to large scale distribution of plants under the Rural Development Scheme.
(f) The department does not stock sugarcane seed for sale apart from such as is available from its seed farms.
(g) Artificial manures are supplied to zamindars directly by manufacturers and no record of their sale is available with the Department of Agriculture, Punjab.
* Revised figures.

APPENDIX VII

Demonstration and propaganda work in India during 1938-39

Province or state	Number of agricultural shows held		Number of practical demonstrations carried out		Number of illustrated lectures given	
	1937-38	1938-39	1937-38	1938-39	1937-38	1938-39
British India						
Madras	354	382	33,981	40,140	777	2,012
Bombay	77	59	3,450	1,908	1,178	616
Bengal	76	70	5,852	8,604	385	450
United Provinces	188	242	24,030	193,675	851	4,641
Punjab	365	475	15,459	23,366	1,653	12,701
Bihar	23	36	32,798*	29,781	212*	180
Central Provinces and Berar	86	97	10,608	11,054	710	131
Assam	10	12	2,594*	2,281	57	53
North-West Frontier Province	6	5	1,870	6,066	313	1,610
Orissa	5	17	6,344	9,341	90	55
Sind	74	123	564	720	93	123
Baluchistan	2	1	6 plots	9 plots	1	2
Ajmer-Merwara	1	1	..	..	1	1

Indian States

Coorg	4	6	18	42	80	60
Hyderabad	77	69	952	838	859	428
Mysore	137	108	3,271	5,687	231	380
Baroda	7*	4	1,606*	1,718	624*	648
Travancore	4	7	172	113	47	46
Cochin	5	8	393	199	9	18
Bhopal	..	6	..	70	..	20
Jammu and Kashmir	5	5	60	63	200	207

*Revised figures.

APPENDIX VIII

Agricultural Colleges and Schools in India during 1938-39

College or school	Course of instruction	1937-38 Applications for admission	1937-38 Admissions made during the year	1937-38 Total No. on the roll	1937-38 Number passed in final examination	1938-39 Applications for admission	1938-39 Admissions made during the year	1938-39 Total No. on the roll	1938-39 Number passed in final examination	Remarks
British India										
Agricultural colleges										
Imperial Agricultural Research Institute, New Delhi.	Two years' post-graduate course.	52 (both courses)	11	30	9	59 (both courses)	14*	32	0	* Two left the course.
	One-year post-graduate course in Farm Management.		6	8	3		5	10	5	
Imperial Dairy Institute, Bangalore.	Post-graduate course (15 months).	12	7	13	6 (completed).	16	9	16 (*a*)	7 (completed).	
	Indian Dairy Diploma course (2 years).	58	28	50	23	No fresh admissions.	4 (*b*)	25 (*c*)	Examination held in alternate years.	
	Short Course ordinary	32	10	10	8 (completed).	..	..	2	2 (completed).	
	Short course post-graduate character.	2	2	3	1 (completed).	35	15	17	12 (completed).	
	Vocational training	11	11	13	23	(*d*)	..	..	..	
Agricultural College, Coimbatore.	B. Sc. (Ag.) degree course of Madras University.	184	48	124	26	187	47	134	29	

	Short courses of practical training in Agriculture—									
	Farm Management	26	20	15	14	21	21	10	9	These are students who completed the course. There was no examination.
	Insect pests and diseases	4	4	3	3	16	14	3	3	
	Horticulture and vegetable gardening.	3	3	2	2	15	13	2	2	
	Dairying	7	7	4	4	17	15	3	3	
	Care of animals	4	4	2	2	12	10	4	4	
	Bee-keeping	7	7	2	2	14	12	5	5	
	Jaggery making	..	..	..	..	13	10	4	4	
	Farm implements and machinery and manures.	7	7	2	2	15	13	4	4	
College of Agriculture, Poona.	Three years' degree course	141	86	172	49	86	71	190	54	
Agricultural College, Cawnpore.	B. Sc. (Agri.) and Intermediate in Agriculture.	107	59	153	30	334	110	214	40	
Allahabad Agricultural Institute.	Indian Dairy Diploma Course.	No admissions were made. ‡		24	No Examination in 1937-38.	52	27	51†	21	† Till December, 1938, 24+2 men repeating were on the rolls in addition to 27 men admitted in July 1938.
	Intermediate in Agric.	171	37	34	27	210	36	33	28	
	B. Sc. in Agric.	28	22	22	14	29	22	21	25	

(a) Includes 7 admitted in January, 1938, completed training in March, 1938.
(b) Repeat course students.
(c) Includes 21 admitted in November, 1937.
(d) Discontinued by the Defence Department.
‡ Admissions to the India Dairy Diploma course are made alternate years and therefore no class was admitted in July 1937.

Agricultural Colleges and Schools in India during 1938-39—contd.

College or school	Course of instruction	1937-38 Applications for admission	1937-38 Admissions made during the year	1937-38 Total No. on the roll	1937-38 Number passed in final examination	1938-39 Applications for admission	1938-39 Admissions made during the year	1938-39 Total No. on the roll	1938-39 Number passed in final examination
	Agricultural colleges—contd.								
The Punjab Agricultural College, Lyallpur.	Four years' B. Sc. Degree Course.	258	82	250	27 (including 7 who appeared in the supplementary examination).	290	94	306	48 (Including 2 compartment students).
	1½ year M.Sc. Degree Course	5	5	5	1	7	7	6	2
	Two years' Leaving Certificate Course.	1	1	1	1	4	4	4	4
	Ten months' Teachers' Training Course.	37	37	37	37	40	32	31	31
	One-year vernacular class	(a)	52	43	40 (including 2 compartment students).	(a)	104	94	89
	Six months' vernacular course *in Dairying.*	26	8	4	4	30	10	7	4
	Two months' Bee-keeping Class at Nagrota.	22	15	11	11	21	16	16	16
	Six weeks' course in Lohar Class.	20	19	19	19	15	15	15	15
	Seven months' Advanced course in Fruit and Vegetable Preservation.	17	7	7	7	7	6	6	6
	Two weeks' Summer Course in Fruit and Vegetable Preservation.	37	37	31	31	37	44	44	44

	Two weeks' Fruit Culture Course.	45	28	23	23	28	17	17	17
	Ten days' Winter Fruit and Vegetable Preservation Course.	40	28	16	16	87	20	20	20
	One-year Mali Class . .	(a)	30	27	26	(a)	80	27	27
	Two months' Bee-keeping Class at Raison (Kulu).	35	27	27	27	26	10	10	19
	Two weeks' Estate Managers Class.	57	33	22	22	21	21	21	21
	Jail Warders' Course . .	(b)	20	20	20	(b)	10	10	10
	Fruit and Vegetable Preservation Class for Sub-Inspectresses of the Cooperative Department.	..	..	..	..	87	37	97	37
Agricultural College, Nagpur	4 years' degree course . .	127	58	163	16	182	54	170	22
*Islamia College, Peshawar	B.Sc. Agriculture . .	24	24	61	2	21	21	74	6
Madras	*Agricultural schools*								
School for juveniles at Coimbatore.	3 R's, I and II standards .	11	11	20	2	28	28	27	5
School for juveniles at Palur Agricultural Research Station near Nellikuppam, District, South Arcot.	3 R's I to V standards .	23	23	38	..	20	20	45	2
School for juveniles at Anakapalli Agricultural Research Station, District Vizagapatam.	Ditto . .	7	7	24	16	27	27	24	23
Bombay									
Marathi Agricultural School, Dhulia (District West Khandesh).	Two years' course . .	84	18	33	10	83	10	33	14

(a) Applications are received by the Deputy Directors of Agriculture.
(b) Selection made by the Jail Department.
* Islamia College Peshawar is a national college. It is not primarily meant for teaching agriculture, but the agricultural classes have recently come into existence, i.e., since 1933.

Agricultural Colleges and Schools in India during 1938-39—concld.

College or school	Course of instruction	1937-38				1938-39			
		Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total No. on the roll	Number passed in final examination
Bombay—contd..				Agricultural schools—*contd.*					
Kannada Agricultural School, Devihosur (District Dharwar).	Two years' course	30	13	32	17	34	17	28	13
Bengal									
Dacca Secondary Agricultural School, P.O., Tejgaon, Dacca.	Two years	318	29	51	18	422	25	54	22
Daulatpur Agricultural Institute.	Two years	48 @	34	34 at the commencement of the session.	As the Institute was started in August 1937 no final examination was held that year.	25	10	20+10 =30 of the first batch only. 20 remained at the beginning of 1938-39.	No final examination was held till 1939-40.
United Provinces									
Agricultural School, Bulandshahr.	2 years' course	100	34	30	30	112	38	34	34
	Fieldman course	96	23	23	23	128	57	52	52
	Farm Mechanic course	81	9	9	9	45	12	8	8
Agricultural School, Gorakhpur.	2 years' course	808	87	87	36	670	71	71	41
Central Provinces									
Agricultural Anglo-vernacular Middle School, Powarkhera, (District, Hoshangabad).	Four years' course	23	28	75	13	17	17	77	14
Ditto Betul Bazar	Ditto	17	17	58	14	46	46	77	12

Indian States

Hyderabad									
Oil Engine Class . .	Two classes in the year of 3 months each.	27	22	25	17	30	18	18	16 179*
Gardeners' Class, Himayatsagar.	Two years' course . .	5	4	9	6	11	8	9	2 28*
Farmers' Class, Himayatsagar.	Ditto . .	29	12	22	10	42	12	18	6 27*
Farmers' Class, Parbhani .	*Ditto* . .	20	12	19	7	31	12	20	8 25*
Farmers' Class, Rudrur .	Ditto . .	18	6	9	4	10	6	11	4 8*
Mysore									
Agricultural School, Hebbal, Bangalore.	Three years . . .	26	*10*	*50*	*18*	44	19	49	11
Baroda									
Seth Dosabhai Maganlal Agricultural Institute.	—	117	29	29	28	115	27	27	27
Travancore									
Agricultural School, Kottarakara.	2 years	32	22	22	..	..	..	..	..
Agricultural School Koni .	Ditto	..	..	20	26	78	30	30	..
Jammu and Kashmir									
Practical Agricultural classes.	One Year	60	20	20	16	44	21(*a*)	21	15
Cochin									
Horticultural School of Central Farms, Trichur and Hill Palace, Trippunithura.	Two Years	60	60	60	46	226	60	110	48

* Total number passed since inauguration of the class.

(*a*) Includes one casual student—Five boys gave up study.

APPENDIX IX

Operation of non-credit agricultural cooperative societies in India during 1938-39.

(A) PURCHASE, SALE AND PRODUCTION.

Province or state	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Madras	Purchase and sale	155	29,156 (including 2,191 societies.)	2,56,213	4,38,504	62,54,968	+35,162
	Production and production and sale.	53	2,478 (including 140 societies.)	..	1,24,204	1,59,523	—2,320
	Others	400	27,828 (including 81 societies.)	1,03,181	6,83,613	33,98,377	—3,06,304
	TOTAL	608	59,462	3,59,394	12,46,381	98,12,868	—2,73,462
Bombay	Purchase and purchase and sale.	71	8,872	74,758	2,89,020	2,68,977	+4,004
	Production	19	660	..	..	8,960	+45
	Production and sale	94	20,731	7,77,484	6,76,712	18,36,738	+71,521
	TOTAL	184	30,263	8,52,242	9,65,732	21,14,675	+75,570

Bengal	Purchase and purchase and sale.	68	19,355	3,23,064	2,05,988	7,62,014	+7,209
	Production	1,001	22,210	..	..	5,08,664	—3,646
	Production and sale	337	15,418	1,33,855	3,14,769	9,78,352	—2,497
	Others (excepting Insurance).	39	9,679	1,318	136	1,32,764	—8,177
	TOTAL	1,445	66,662	4,58,237	5,20,893	23,81,794	—7,111
United Provinces	Purchase and sale	15	2,017	15,701	13,039	10,199	+3,020
	Production and sale	1,094	2,23,235	22,91,000	22,57,287	17,24,513	+2,76,341
	TOTAL	1,109	2,25,252	23,06,701	22,70,326	17,34,712	+2,79,361
Punjab	Purchase and purchase and sale.	16	1,316	94,008	85,839	71,095	+2,307
	Production	370	8,476	..	..	8,937	+476
	Production and sale	1,793	1,73,275	36,28,547	36,80,525	6,54,141	—34,519
	Others	117	2,798	..	..	1,07,347	—14,304
	TOTAL	2,296	1,85,865	37,22,555	37,66,364	8,41,520	—46,040

Operations of non-credit agricultural cooperative societies in India during 1938-39—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province or state	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Bihar	Purchase, purchase and sale	25 (including 12 cane co-operative marketing Unions).	513	2	..	9,955	+7,760
	Production and sale	374	7,664	1,051	..	17,908	+1,374
	TOTAL	399	8,177	1,053	..	27,863	+9,134
Central Provinces and Berar.	Purchase and sale	60	3,152	1,54,138	62,549	3,51,127	+6,813
	Production	17	447	..	..	9,709	+1,839
	Production and sale	9	549	65,816	64,867	17,035	+58
	TOTAL	86	4,148	2,19,954	1,27,416	3,77,871	+8,710
Assam	Production	1	207	..	..	6,634	—66
	Production and sale	16	272	3,947	3,756	5,016	+237
	TOTAL	17	479	3,947	3,756	11,650	+171

North-West Frontier Province.	Purchase sale and production	36	9,868	2,48,095	2,43,543	49,538	2,541
Orissa . . .	Agricultural purchase and sale.	9	5,614	22,001	17,408	76,105	+3,915
	Agricultural production and sale	3	267	3,323	..	13,689	+168
	TOTAL .	12	5,881	25,324	17,408	89,794	+4,083
Sind† . . .	Purchase and sale .	3	989	..	..	4,95,789	+5,526
	Production and sale .	15	817	..	..	3,52,323	+7,003
	TOTAL .	18	1,806	..	..	8,48,112	+12,529
Coorg	Purchase and sale .	23	3,193	1,07,739	38,568	1,17,684	+1,457
Delhi . . .	Production . . .	9	187	..	..	143	27
	Production and sale .	31	2,797	..	..	497	112
	TOTAL .	40	2,984	..	..	640	139
Hyderabad . .	Purchase and sale .	99	2,392	61,259	..	2,77,378	+5,427
	Sale and production .	18	2,047	92,658	93,461	93,068	+4,578
	TOTAL . .	117	4,439	1,53,917	93,461	3,70,446	+10,005

† NOTE.—The Sale Societies in Sind (both Purchase and Sale and Production and Sale) are doing sale business on behalf of their members on commission basis only.

Operations of non-credit agricultural cooperative societies in India during 1938-39—contd.

(A) PURCHASE, SALE AND PRODUCTION—*concld.*

Province or state	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Mysore	Purchase and purchase and sale	22	542	520	418	75,252	+149
	Production and sale	19	461	20,548	19,810	22,332	+946
	Others	33	628	..	..	14,020	+778
	TOTAL	74	1,631	21,068	20,228	1,11,604	+1,873
Baroda	Purchase and sale	11	765	21,339	21,946	12,123	+876
	Production	27	1,259	5,047	5,446	1,15,170	+11,847
	Production and sale	38	2,878	4,62,044	4,16,191	1,53,943	+3,477
	Others	108	6,357	..	100	9,115	+522
	TOTAL	184	11,259	4,88,430	4,43,683	2,90,351	+16,722

Travancore	Production	1	52	..	..	246	—13
	Production and sale	10	758	17,489	20,199	8,832	+200
	TOTAL	11	810	17,489	20,199	9,078	+187
Cochin	Purely agricultural	3	103	..	1,735	5,406	+494
Jammu and Kashmir	Mulberry culture	6	96	..	..	..	..
	Fruit Growers	1	70	..	..	333	..
	Experimental farming	1	86	..	..	96	..
	Agricultural development.	2	103	..	..	67	67
	Consolidation of holdings.	188	10,550	..	..	..	..
	TOTAL	198	10,906	..	..	496	67

Operations of non-credit agricultural cooperative societies in India during 1938-39—contd.

(B) CATTLE INSURANCE

Province or state	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of animals		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid *for* re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
Bombay . . .	1	..	..	..	..	..	..	2	232	..	..

APPENDIX X

Working of the Veterinary Departments in India, 1938-39

Province	Reported mortality from contagious diseases			Dispensaries and hospitals			District work					
	Rinder-pest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculations were undertaken	Deaths uninoculated	Inoculations	Deaths after inoculations
1	2	3	4	5	6	7	8	9	10	11	12	13
British India												
Madras	9,986	25,611	35,597	118	2,76,459	28,901	2,12,512	64,499	2,769	28,594	7,49,819	436
Bombay	1,881	20,092	21,973	120	2,27,602	37,951	93,918	14,519	1,502	8,889	1,80,466	132
Bengal	14,174	9,559	23,733	50	1,09,111	1,076	2,49,490	7,849	1,158	16,633	2,54,666	2,409
United Povinces	27,360	17,632	44,992	192	5,29,761	1,06,146	1,32,678	19,425	3,429	33,239	5,40,950	391
Punjab	17,241	13,520	30,761	314	17,69,661	403,453	7,56,909	2,32,802	5,371	16,951	12,64,917	982
Bihar	7,826	10,729	18,555	30	1,19,576	22,380	4,30,088	93,446	1,147	5,289	6,16,720	295
Orissa	2,440	1,163	3,603	30	66,613	3,774	1,22,408	25,604	241	1,985	2,06,186	188
Central Provinces	8,057	11,618	19,675	106	2,42,521	26,644	4,41,080	74,130	3,068	10,695	5,94,049	50
Assam	34,120	16,787	50,907	3	7,884	542	1,75,190	30,758	1,455	28,362	2,87,142	1,736
North-West Frontier Province	509	2,201	2,710	71	3,02,614	61,922	1,18,493	40,970	221	1,310	97,667	580
Sind	1,221	9,917	11,138	24	32,167	3,559	1,15,250	1,193	129	553	11,873	42
Baluchistan	0	4,708	4,708	10	37,521	555	48,378	24	7	182	1,196	11
Ajmer-Merwara	21	2,156	2,177	3	6,661	973	1,778	2	17	1,143	2,819	276
Coorg	49	390	439	8	72,282	525	4,191	1,383	74	227	2,749	10
TOTAL BRITISH INDIA	1,24,885	1,46,083	2,70,968	1,049	37,88,438	6,90,401	29,42,368	6,06,604	20,588	1,54,052	37,64,219	7,487

Working of the Veterinary Departments in India, 1938-39—concld.

Province	Reported mortality from contagious diseases.			Dispensaries and hospitals			District work					
	Rinder-pest	Other diseases	Total	Number of institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculations were undertaken	Deaths uninoculated	Inoculations	Deaths after inoculations
1	2	3	4	5	6	7	8	9	10	11	12	13
Indian States												
Hyderabad	2,075	6,698	8,773	130	323,200	13,477	..	..	488	6,019	1,67,917	78
Mysore	2,620	13,682	16,402	79	3,55,888	31,081	82,802	52,146	..	8,288	2,81,099	631
Baroda	38	929	967	85	25,051	1,120	18,487	1,876	55	808	6,492	10
Travancore		110	..	15	28,373	2,623	8,859	..	..	..	5,109	..
Cochin				9	29,512	1,281	2,045	394	..	..	..	..
Bhopal	..	..	..	4	25,578	..	4,072	2,248	67	..	4,909	..
Jammu and Kashmir	592	715	1,307	28	1,57,200	14,993	78,173	10,069	77	1,301	15,712	6

APPENDIX XI

Working of the veterinary colleges and schools in India during 1938-39

Veterinary college or school	Length of course	NUMBER OF STUDENTS						EDUCATIONAL QUALIFICATIONS OF STUDENTS ADMITTED		
		ADMITTED DURING THE YEAR		Passed final examination	Failed in final examination	UNDER INSTRUCTION AT THE END OF YEAR		Intermediate and above	Matriculate or S. L. C.	Lower qualifications
		Scholarship-holders	Others			Ordinary course	Failed students			
Imperial Dairy Institute, Bangalore—										
Indian Dairy Diploma	2 years	2	21	*	..	22	*			
Post-graduate course	15 months	..	8 (old batch) 8 (new batch)	..	..	8	..	34	14	9
Short course	2 months and upwards.	1	17	..	..	6	..			
Madras Veterinary College—										
G. M. V. C. Diploma	3 years	..	..	..	..					
B. V. Sc. Degree	3 years and 1 term.	..	..	October 1938 9	..					
G. M. V. C. Diploma	4 years	1	3	March 1939 20	2 ..	110	16	43	4	..
B. V. Sc. Degree	5 years	3	40	..	9 ..					
Bombay Veterinary College	3 years	10	25	18	19	90	49	1 B.Sc. (Agri.). 2 Inter-Science.	16 First year Arts. 16 Matriculates.	..
Bengal Veterinary College	3 years	30	37	53	16	204	39	24	39	4
Punjab Veterinary College	4 years	1	86	11	1	251	1	75	12	..
Bihar Veterinary College	3 years	35	**11	22	4	68	@11	†20	26	..

* No I. D. D. examination was held in the year 1938-39.
** Private students.
@ Including 2 plucked students of class 'A' allowed to return in the beginning of the session 1939-40.
† Including one Intermediate in Commerce.

APPENDIX XII

Number of cattle issued from the Government farms during 1938-39

Province or state	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1938-39	Total for 1937-38
British India							
Imperial Agricultural Research Institute, New Delhi.	5	21	..	..	22	48	37
Agricultural Sub-station, Karnal.	3	32	..	..	32	67	272*
Imperial Dairy Institute, Bangalore.	..	41	..	3	83	127	92
Madras	46	63	1	1	9	120	120
Bombay . . .	55	30	28	5	78	196	205
Bengal	16	..	4	.	..	20	24
United Provinces . .	965	127†	78	171†	..	1,341	646@
Punjab	581	6	..	..	146	733	1,364
Bihar	1	44	..	6	69**	120	220@
Central Provinces and Berar	47	37	7	4	27	122††	221‡
Assam	49	27	..	..	25	101	42†
Sind . . .	99	..	..	..	..	99	20
Indian States							
Hyderabad . . .	14	..	..	..	..	14	10@
Mysore	20	16	..	..	59	95	118
Cochin	2	1	—	—	10	13	51

* Includes animals of Hariana breed transferred to Imperial Institute of Veterinary Research, Izatnagar.
** Including 1 bullock.
† Purchased and issued direct from the purchasing centre.
@ Revised figures.
†† Out of these 8 issued free to Gourakshans.
‡ Out of these 36 issued free on account of some defect or other.

APPENDIX XIII (A)

Imports into India by sea of animals and animal products for the five years ending March 1939

Description of articles		Quantity					Value in Rupees				
		1934-35	1935-36	1936-37	1937-38	1938-39	1934-35	1935-36	1936-37	1937-38	1938-39
1. Live animals—											
Horses	No.	3,061	2,941	2,197	3,969	3,210	23,15,501	24,20,852	13,26,999	33,29,751	28,18,452
Other animals . . .	,,	6,360	6,838	7,776	8,008	7,269	1,78,340	2,21,680	2,40,678	2,02,773	2,53,578
TOTAL .	,,	9,421	9,779	9,973	11,977	10,479	24,93,841	26,42,532	15,67,677	35,32,524	30,72,030
2. Hides and skins—											
Hide, raw . . .	Tons	650	559	522	1,164	1,088	2,29,708	2,13,710	2,33,044	4,26,259	3,84,394
Skins, raw . . .	,,	1,361	1,368	1,040	1,619	1,593	8,07,327	7,86,651	9,69,701	15,44,406	12,41,728
TOTAL RAW HIDES AND SKINS	,,	2,011	1,927	1,562	2,783	2,681	10,37,035	10,00,361	12,03,345	19,70,665	16,26,122
Tanned hides . . .	,,	11	3	53	3	2	49,630	49,179	57,938	29,785	28,681
Tanned skins . . .	,,	188	135	132	184	129	14,55,784	11,03,292	11,67,718	17,47,299	11,88,899
TOTAL TANNED HIDES AND SKINS	,,	199	138	185	187	131	15,05,414	11,52,471	12,25,656	17,77,084	12,17,580
TOTAL HIDES AND SKINS RAW AND TANNED	,,	2,210	2,065	1,747	2,970	2,812	25,42,449	21,52,832	24,29,001	37,47,749	28,43,702

Imports into India by sea of animals and animal products for the five years ending March 1939—contd.

Description of Articles		Quantity					Value in Rupees				
		1934-35	1935-36	1936-37	1937-38	1938-39	1934-35	1935-36	1936-37	1937-38	1938-39
3. Wool and woollen products—											
Raw wool	Lb.	5,985,184	7,485,249	6,773,726	8,173,058	7,296,107	41,35,017	44,10,193	59,52,313	84,80,425	62,11,361
Knitting wool	,,	1,858,144	1,038,579	1,224,657	1,196,243	1,195,428	31,59,817	17,12,190	23,31,374	29,22,638	25,13,963
Worsted yarn for weaving	,,	1,638,438	1,086,197	950,805	1,629,150	2,160,426	28,80,098	18,26,576	18,33,415	37,93,174	38,27,851
Blankets and rugs	,,	6,665,145	4,610,205	3,528,138	5,211,839	4,078,133	54,98,736	35,12,792	25,48,609	39,37,938	31,57,417
Braids	,,	39,849	8,640	4,887	6,182	6,764	30,359	22,007	15,120	20,797	21,335
Carpets and floor rugs	,,	160,574	201,742	212,877	157,242	143,787	3,41,712	3,92,012	4,13,075	4,04,826	2,42,288
Hosiery	,,	408,839	..	..	..	..	12,25,354	..	..	..	..
Knitted apparel	,,	..	485,504	356,256	250,666	267,727	..	11,10,567	10,11,652	8,73,506	9,13,549
Piecegoods	Yds.	10,516,080	5,259,596	5,445,328	6,722,866	2,498,200	1,39,82,875	81,00,665	84,29,171	1,12,51,516	45,07,554
Shawls and lohis	No.	415,963	500,259	494,760	492,815	478,788	11,96,519	11,46,114	12,89,836	18,30,668	13,86,583
Total	,,	..	..	..	..	..	3,24,49,987	2,22,42,116	2,38,24,565	3,35,15,503	2,27,81,901
4. Dairy Products—											
Butter	Cwt.	6,265	7,708	8,486	7,674	8,230	6,23,654	6,95,706	8,28,314	7,28,681	8,57,544
Cheese	,,	10,924	10,546	11,569	10,205	10,373	8,43,892	7,04,438	7,97,155	7,48,430	7,37,191
Milk foods, etc.	,,	9,174	10,395	8,666	8,687	9,716	13,67,711	16,50,947	15,44,261	17,08,688	18,32,151
Milk condensed and preserved.	,,	180,942	209,214	210,870	59,115	62,068	48,36,976	54,21,165	54,43,618	19,37,175	20,05,116
Ghee	,,	339	371	217	347	174	14,911	16,430	9,001	18,869	9,964
Total	,,	207,644	238,234	239,252	86,118	90,561	78,86,044	85,48,686	86,22,349	51,41,843	54,41,966

5. Other Animal Products—											
Animal oils	Galls.	..	..	..	..	..	3,77,238	3,90,014	3,44,801	3,03,895	2,79,927
Fish, canned	Cwt.	46,780	64,087	89,505	12,850	13,249	10,80,623	14,16,801	16,39,828	6,30,810	6,37,182
Fish, excluding canned	,,	96,672	110,202	99,292	76,370	94,200	16,56,845	19,34,212	17,80,084	6,70,266	6,89,164
Isinglass	,,	880	591	801	395	431	1,01,264	82,922	1,11,459	78,435	78,690
Bacon and ham	,,	15,838	17,090	18,246	16,895	16,810	11,48,932	12,36,255	13,20,958	12,47,681	12,87,386
Codliver oil	Lb.	99,106	106,431	196,351	164,924	280,516	45,849	45,495	85,704	92,717	1,88,654
Fish manure	Tons	1,143	1,479	2,616	1,783	2,349	92,746	1,12,846	1,73,313	58,239	72,538
Hair	Cwt.	1,855	2,179	6,619	2,312	5,653	42,860	56,281	1,75,802	58,864	1,22,748
Manufactures of hair	,,	..	..	..	..	..	24,067	32,463	52,159	45,794	48,497
Lard	,,	784	695	571	218	185	31,590	38,947	30,910	15,182	11,238
TOTAL	,,	..	..	..	..	..	46,01,514	58,46,176	57,14,518	32,01,883	33,61,024
GRAND TOTAL		..	..	..	..	..	4,97,74,435	4,09,32,342	4,21,58,110	4,91,89,002	3,75,00,628

APPENDIX XIII (B)

Exports from India by sea of animals and animal products for the five years ending March 1939

Description of articles	Quantity					Value in Rupees				
	1934-35	1935-36	1936-37	1937-38	1938-39	1934-35	1935-36	1936-37	1937-38	1938-39
1. Animals—										
Cattle . . . . . No.	778	407	87	1,848	1,436	61,771	31,905	8,215	1,10,199	83,505
Horses . . . . . ,,	69	28	16	14	15	2,16,230	32,400	22,300	20,540	11,850
Sheep and goats . . . ,,	47,338	39,918	35,774	33,465	30,400	8,39,428	7,23,472	6,03,180	6,29,352	6,00,086
Other animals . . . ,,	119,510	227,680	180,652	104,655	147,028	1,06,849	1,38,421	1,97,773	1,13,042	1,27,085
TOTAL ,,	167,695	268,037	216,529	229,982	178,870	12,24,278	9,26,198	8,31,468	8,79,133	8,22,526
2. Hides and skins—										
Buffalo hides, raw . . Tons	2,888	2,693	4,480	4,385	1,803	11,61,590	10,64,413	21,57,082	29,67,983	12,88,098
Cow hides, raw . . . ,,	19,271	19,462	19,417	16,771	13,286	95,59,034	98,12,544	1,09,41,622	1,22,75,667	87,41,687
Calf skins . . . . ,,	480	522	314	453	318	2,30,321	3,39,338	2,36,165	4,57,111	2,36,282
Other hides . . . . ,,	..	..	35	2	23	..	510	4,000	640	31,700
TOTAL HIDES, RAW . ,,	22,589	22,677	24,246	21,611	15,480	1,09,50,945	1,12,16,805	1,33,38,819	1,57,01,401	1,03 42,616

Goat skins, raw	,,	3,873	20,108	17,985	18,573	18,676	1,80,72,991	2,78,31,671	2,78,13,430	3,07,27,104	2,56,70,806
Sheep skins, raw	,,	1,176	938	603	800	827	15,71,812	14,31,716	14,59,046	13,71,680	9,63,248
Other skins	,,	110	154	245	364	412	6,04,813	5,27,880	8,63,782	15,70,831	12,35,492
TOTAL SKINS, RAW	,,	15,159	21,195	18,833	19,737	19,915	2,02,44,616	2,97,01,276	3,01,36,267	3,36,69,705	2,78,69,546
TOTAL RAW	,,	37,748	43,872	48,079	41,348	35,845	3,12,00,561	4,10,08,081	4,34,75,086	4,93,71,106	3,81,12,161
Hides, tanned and dressed	,,	11,370	14,029	17,897	16,958	14,743	1,97,63,385	2,29,06,363	3,17,56,941	3,20,72,727	2,27 40,144
Skins, tanned and dressed	,,	6,546	6,275	7,472	6,724	5,448	3,24,50,744	2,91,10,870	3,56,53,263	3,24,63,062	2,48,14,564
TOTAL TANNED AND DRESSED	,,	17,916	20,304	25,369	23,682	20,191	5,22,14,129	5,20,17,233	6,74,10,204	6,45,35,789	4,75,54,708
TOTAL HIDES AND SKINS, RAW AND TANNED	,,	55,664	64,176	68,448	65 030	55,536	8,34,14,690	9,30,25,314	11,08,85,290	11,39,06,895	8,56,66,869
3. Wool—											
Raw wool	Lb.	34,075,204	49,352,285	51,937,719	37,989,319	55,415,743	1,27,49,752	2,09,66,129	2,86,08,005	2,64,55,835	2,98,68,271
Carpets and rugs	,,	10,093,364	9,347,108	9,897,803	11,061,354	8,945,008	89,81,365	80,64,638	85,63,699	1,02,47,274	81,55,901
Piecegoods	Yds.	60,542	26,820	29,693	87,410	19,306	80,531	34,470	25,795	89,663	27,321
Shawls	No.	9,662	21,842	21,810	39,176	25,752	37,810	76,500	77,775	1,20,924	73,839
Other sorts	Lb.	149,075	268,704	234,271	329,806	382,657	77,905	1,14,114	1,14,199	3,23,698	3,69,227
TOTAL		..	..	..	..	..	2,19,27,363	2,92,55,851	3,73,89,473	3,72,37,394	3,84,94,559
4. Dairy Products—											
Butter	Cwt.	1,898	2,289	1,776	6,221	6,474	1,71,965	2,04,378	1,58,273	5,98,955	6,26,007
Cheese	,,	29	31	15	31	54	2,495	2,601	921	2,002	1,950
Ghee	,,	25,526	24,030	26,998	45,220	44,458	14,64,001	14,92,074	16,15,247	28,76,432	27,81,047
TOTAL	,,	27,458	26,850	28,789	51,472	50,986	16,38,461	16,99,053	17,74,441	34,77,389	34,09,004

Exports from India by sea of animals and animal products for the five years ending March 1939—contd.

Description of articles	Quantity					Value of Rupees				
	1934-35	1935-36	1936-37	1937-38	1938-39	1934-35	1935-36	1936-37	1937-38	1938-39
5. Other Products—										
Bones for manufacturing . Tons	52,378	53,193	74,279	61,253	31,187	31,95,585	32,19,484	46,45,437	43,82,558	23,71,295
Bones for manure . . ,,	8,368	14,418	25,518	31,910	15,424	5,02,457	10,05,344	*20,34,019*	*31,98,132*	*11,84,478*
Bonemeal . . . ,,	28,106	28,476	31,729	36,920	25,072	4,31,159	13,94,100	15,82,941	19,98,750	14,85,764
Casein . . . . Cwt.	7,952	11,452	12,577	7,507	5,500	1,55,541	2,24,572	3,32,667	1,79,093	75,164
Fish, dry, salted . . ,,	135,949	147,164	152,636	121,292	119,592	23,05,666	24,11,789	23,40,548	23,01,248	20,90,461
Fish, dry, unsalted . . ,,	96,746	105,781	116,049	208,076	205,198	14,59,715	14,94,007	15,28,459	40,64,990	42,80,517
Fishmaws and sharkfins . ,,	7,370	6,344	6,709	5,066	5,959	6,00,185	5,89,236	5,91,205	5,03,695	5,16,497
Fish, wet, salted . . ,,	11,027	8,195	4,365	4,090	5,224	89,028	64,727	35,572	38,670	41,894
Fish manures . . . Tons	5,164	6,165	6,583	6,398	4,710	3,80,062	4,35,113	4,69,634	5,59,178	3,79,374
Guano . . . . . ,,	1,219	139	923	519	178	97,772	8,214	86,306	48,680	19,045
Horn tips and pieces of horn Cwt.	34,821	37,287	69,525	59,540	31,709	2,47,377	2,82,347	4,37,391	4,09,084	2,36,380
Lard . . . . . ,,	16	..	..	..	..	150	..	..	..	..
TOTAL .	..	..	..	..	..	1,05,54,642	1,11,28,934	1,40,84,179	1,76,83,179	1,26,80,794
GRAND TOTAL .	..	..	..	..	..	11,87,59,434	13,60,35,350	16,49,64,851	17,31,83,990	14,10,73,752

APPENDIX XIII (C)

Inter-provincial trade in livestock and livestock products during 1938-39

Provinces, states and ports.	Animals—Livestock.							
	Cattle—Excluding Sheep and Goats		Horses, Ponies and Mules		Sheep and Goats		Others	
	Import	Export	Import	Export	Import	Export	Import	Export
1	2	3	4	5	6	7	8	9
	No.	No.	No.	No.	No.	No.	No.	No.
1. Assam	994	475	162	94	596	51	340	467
2. Bengal	12,969	6,327	1,051	448	3,083	1,30,983	6,704	15,992
3. Bihar	19,559	34,586	1,850	954	9,538	2,50,747	19,202	13,998
4. Orissa	235	24,842	39	145	59	7,622	483	539
5. United Provinces	41,390	10,148	5,024	3,008	3,103	1,04,769	6,305	42,696
6. Punjab	5,005	1,17,244	2,155	7,782	6,806	3,176	8,862	4,692
7. Delhi	6,308	8,106	2,180	1,472	8,059	1,477	3,178	2,760
8. North-West Frontier Province.	8,685	372	807	699	322	2,131	846	2,315
9. Sind and Baluchistan	500	1,981	239	396	81	8,992	840	1,388
10. Central Provinces	2,827	1,773	662	324	660	23,613	674	668
11. Bombay	20,919	26,604	2,648	2,050	4,27,458	910	4,687	3,266
12. Madras	2,291	5,590	596	351	23,941	68,312	19,369	1,79,026
13. Rajputana	1,302	8,486	788	540	135	3,60,687	2,165	827
14. Central India	1,200	4,220	801	233	12,175	46,690	602	560
15. Nizam's Territory	389	179	499	746	35	20,343	803	930
16. Mysore	533	958	1,064	795	36,369	21,728	28,519	5,169
17. Kashmir	134	2	354	101	35	11	80	108
18. Calcutta*	80,625	9,430	1,410	1,442	4,79,425	536	41,257	4,938
19. Bombay Port*	59,988	9,789	1,894	2,498	806	225	2,959	3,824
20. Karachi*	983	33	166	154	8,714	66	602	433
21. Madras Chief Port*	1,232	326	344	422	155	60	1,29,275	3,599
22. Madras Ports (*excluding* Chief Port). *	4,262	850	47	27	31,792	209	24,869	14,443
TOTAL 1938-39	272,330	272,330	24,780	24,780	1,053,347	1,053,347	302,621	302,621
TOTAL 1937-38	260,631	260,631	25,367	25,367	930,513	930,513	352,188	352,188

* NOTE.—Trade shown against Calcutta, Bombay Port, Karachi, Madras Chief Port and Madras Ports (*excluding* Chief Port), is *exclusive* of what is mentioned above against the respective Provinces in which they are situated.

Inter-provincial trade in livestock and livestock products during 1938-39—contd.

Provinces, states and ports.	Bones		Hides—Raw		Skins—Raw	
	Import	Export	Import	Export	Import	Export
	10	11	12	13	14	15
	Maunds.	Maunds.	Maunds.	Maunds.	Maunds.	Maunds.
1. Assam . . .	56	7,581	224	70,430	5	3,291
2. Bengal . . .	949,625	119,891	56,705	396,604	3,360	64,352
3. Bihar	65	226,768	4,766	284,896	3,129	66,177
4. Orissa . . .	1,611	47,377	17,384	91,018	289	11,974
5. United Provinces .	70,898	472,575	122,043	212,898	16,827	97,621
6. Punjab . . .	2,389	502,275	55,125	105,937	36,665	1,13,222
7. Delhi	25,982	46,744	24,908	24,972	68,052	74,597
8. North-West Frontier Province.	..	24,677	705	75,482	885	23,484
9. Sind and Baluchistan .	534,025	336,842	1,615	44,240	4,375	60,191
10. Central Provinces .	961	181,227	4,297	69,862	4,728	87,998
11. Bombay . . .	49,072	156,527	50,950	18,288	6,999	1,05,964
12. Madras . . .	152,685	226,173	362,524	33,429	215,492	92,330
13. Rajputana . . .	5,180	173,326	15,612	7,645	4,702	44,211
14. Central India . .	2,108	87,386	2,810	14,261	1,374	17,112
15. Nizam's Territory .	..	187,480	656	10,215	4,152	28,001
16. Mysore . . .	6	86,904	80,576	4,216	20,162	71,006
17. Kashmir . . .	..	1,148	49	1,959	46	1,230
18. Calcutta* . . .	219,828	24,701	598,288	151,741	184,507	7,841
19. Bombay Port* . .	128,244	3,776	40,253	18,300	120,397	9,616
20. Karachi* . . .	491,177	160,051	109,535	571	169,401	672
21. Madras Chief Port* .	148,405	14,724	133,033	28,698	122,795	23,325
22. Madras Ports (excluding Chief Port).*	189,980	29,289	818	22,164	1,804	84,941
TOTAL 1938-39 .	2,967,442	2,967,442	1,687,826	1,687,826	990,156	990,156
TOTAL 1937-38 .	6,086,899	6,086,899	1,812,997	1,812,997	1,156,514	1,154,514

Inter-provincial trade in livestock and livestock products during 1938-39—concld.

Provinces, states and ports.	Hides and Skins, Tanned and Leather		Ghee		Wool—Raw	
	Import	Export	Import	Export	Import	Export
	16	17	18	19	20	21
	Maunds.	Maunds.	Maunds.	Maunds.	Maunds.	Maunds.
1. Assam	748	111	7,332	1,253	4	105
2. Bengal	12,892	724	94,146	4,615	415	94,301
3. Bihar	8,429	1,261	28,701	93,838	4,267	1,057
4. Orissa	260	3,618	18,195	660	5	20
5. United Provinces .	37,635	30,562	41,992	230,070	70,767	20,499
6. Punjab	14,809	41,292	12,844	66,553	60,299	113,905
7. Delhi	3,116	416	17,266	1,357	1,212	2,778
8. North-West Frontier Province.	33,800	922	21,204	3,604	495	14,682
9. Sind and Baluchistan .	9,776	328	18,913	10,552	2,160	135,696
10. Central Provinces	3,392	7,478	4,638	36,497	367	667
11. Bombay . . .	22,953	37,543	18,159	31,123	78,157	49,474
12. Madras . . .	23,859	231,881	3,811	128,413	3,035	41,659
13. Rajputana . . .	5,812	3,097	9,673	30,147	37,882	180,134
14. Central India . .	5,952	581	2,968	42,643	710	6,941
15. Nizam's Territory .	1,888	46,772	939	1,553	4	20,669
16. Mysore . . .	3,307	86,584	11,245	2,057	9,776	6,581
17. Kashmir . . .	762	298	3	190	196	106
18. Calcutta* . . .	19,294	59,829	285,463	12,513	92,388	67,512
19. Bombay Port* .	59,838	28,879	55,917	3,347	184,896	4,918
20. Karachi* . . .	1,420	3,514	22,761	2,545	247,462	4,376
21. Madras Chief Port* .	363,804	45,783	15,40	1,378	23,563	2,375
22. Madras Port (*excluding* Chief Port).*	3,494	1,776	20,934	699	1,101	31
TOTAL 1938-39 .	687,249	687,249	712,513	712,513	768,681	768,681
TOTAL 1937-38 .	610,111	610,111	762,690	762,690	573,911	573,911

* Trade shown against Calcutta, Bombay Port, Karachi, Madras Chief Port and Madras Ports (*excluding* Chief Port), is exclusive of what is mentioned above against the respective Provinces in which they are situated.

APPENDIX XIII (D)

Statistics of animals slaughtered in recognised slaughter houses, 1938-39

Provinces.	Bovines.	Ovines.	Pigs.	Others.	Total.
1. Madras	98,114	1,326,823	5,251	..	1,430,188
2. Bombay	228,876	1,538,564	3,549	208	1,771,197
3. Bengal	218,647	594,032	3,261	4,900	820,840
4. United Provinces	301,879	775,209	1,222	2,672	1,080,982
5. Punjab	150,323	1,261,224	2,572	6,858	1,420,977
6. Bihar	103,448	345,223	1,620	..	450,291
7. Orissa	10,304	84,522	..	3	94,829
8. Central Provinces	64,733	220,703	311	..	285,747
9. Assam	Information not available.				
10. North-West Frontier Province	27,820	213,520	..	..	241,346
11. Sind	2,271	208,099	..	181	210,551
12. Baluchistan	2,269	114,117	..	..	116,386
13. Ajmer-Merwara	..	95,402	..	..	95,402
14. Coorg	..	19,755	..	..	19,755
TOTAL	1,208,690	6,797,193	17,786	14,822	8,038,401

APPENDIX XIV

Staff of central, provincial and state Veterinary Departments in India during 1938-39

Province or state.	SUPERIOR STAFF				SUBORDINATE STAFF			
	ADMINISTRATIVE		RESEARCH AND TEACHING		RESEARCH AND TEACHING		FIELD STAFF	
	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively
British India								
Imperial Dairy Institute, Bangalore.	2	2	2	2	6	6	..	..
Wellington Milk Depôt, Wellington.	..	..	..	..	2	2	..	..
Imperial Veterinary Research Institute, Mukteswar.	1	1	20	20	36	30	..	..
Madras . . .	16	14	10	10	24	22	207	199
Bombay . . .	4	3	7	6	4	4	149	142
Bengal . . .	6	2	8	7	4	4	194	181
United Provinces .	4	2	1	1	..	..	250	226
Punjab . . .	26	21	17	17	13	13	423	382
Bihar . . .	5	4	8	5	8	8	96	96
Central Provinces and Berar.	7	6	1	..	2	2	168	160
Assam . . .	1	1	1	1	..	..	73	66
North-West Frontier Province.	2	2	2	1	..	..	63	63
Orissa . . .	1	1	1	1	..	..	39	39
Sind	1	1	2	2	..	..	36	31
Baluchistan . .	1	1	..	..	..	..	24	22
Ajmer-Merwara . .	1	..	..	..	..	..	..	..
Coorg . . .	..	..	..	..	..	..	6	6
Indian States								
Hyderabad . .	6	6	1	1	..	..	182	130
Mysore . . .	106	92	..	..	..	..	286	186
Baroda . . .	1	1	..	..	1	..	46	40
Travancore . .	15	15	1	1	..	..	16*	16*
Cochin . . .	12	12	..	..	..	..	20	20
Bhopal . . .	1	1	..	..	..	..	27	27
Jammu and Kashmir .	8	8	..	..	..	..	31	31

* 2 Temporary.

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	Breed	TOTAL NUMBER OF LIVESTOCK — Cattle (including buffaloes) — Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Imperial Veterinary Research Institute, Mukteswar.	Mukteswar Dairy Farm.	..	Estate Manager.	Director	Grade (European).*	1 Buff. stud Bull. 1 grade Bull. 1 Afghan Bull. 1 Hill Bull.	24 Grade. 10 Hill cows. 3 Buff.-cows plain. 3 Buff.-cows, Nill.	7 Grade. 9 Hill. 8 Buff.	6 Grade. 5 Hill. 3 Buff.
Imperial Veterinary Research Institute, Izatnagar.	*Izatnagar Dairy*	..	*Cattle Superintendent.*	*Do.*	*Hariana*	8 stud Bulls.	45	31	32
Imperial Department of Agriculture.	I. A. R. I., *New Delhi*	400	Cattle Research Assistant.	Imperial Agriculturist.	Sahiwal	10	68	69	68
	Agri. Sub-station, Karnal.	2,100	Farm Superintendent.	Do	Tharparkar.	8	82	86	55
Imperial Dairy Department.	Imperial Dairy Institute, Bangalore.	212	Superintendent.	Imperial Dairy Expert.	Ayrshire	2	1	1	..
					Cross-bred.	..	64	27	18
					Sindhi	8	78	55	35
					Gir	3	20	19	2
					Buffs. Murrah.	2	22	17	8
	Milk Depot, Wellington.		Supervisor-In-charge.	*Do.*	Cross bred.	..	31	..	2
					Sindhi	1	..	..	..
	Livestock Research *Station, Hosur* Cattle Farm P. O., Salem District.	1,660	Superintendent.	Livestock Development Officer, Hosur Cattle Farm P. O. (Salem District).	Kangayam.	73	107	66	90
					Sindhi	43	60	49	39
					Cross-bred.	23	20	21	17
					Hallikar	18	23	15	18
					Sheep	..	..	..	..
					Poultry—White Leghorn. Rhode Island Red. Light Sussex. Black Minorca. Chittagong. Country local.				

DIX XV.

farms in India during 1938-39.

On the farm on 30th June 1939				Poultry	Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels				
11	12	13	14	15	16	17	18
						Rs.	Rs.
							These herds are maintained for experimental purposes.
..	..	..	..	..	19	20,328	51,000
..	..	..	..	..	22	12,890	34,257
..	..	..	..	..	....	72,734	1,30,512
..	..	..	..	..	....	39,432	36,856
..	..	..	..	..	Bulls . . 45 Rams . . *Nil* Poultry . 619 Eggs . . 2,288	15,471	32,922
31	..	..	..	..	....	..	..
..	..	..	..	58	....	..	..
..	..	..	..	52	....	..	..
..	..	..	..	38	....	..	..
..	..	..	..	66	....	..	..
..	..	..	..	39	....	..	..
..	..	..	..	6	....	..	..

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	Breed	TOTAL NUMBER OF LIVESTOCK — Cattle (including buffaloes) — Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Madras	Livestock Research Station, Lam P. O., Guntur.	238	Farm Manager.	Livestock Development Officer, Hosur Cattle Farm, P. O. (Salem District).	Ongole	23	16	9	11
					Buffaloes	5	7	7	5
					Poultry.				
Bombay	1. Northcote Cattle Breeding Farm, Chharodi.	2,279	Manager	Livestock Expert to Govt., B. P. Poona.	Kankrej	83	93	101	76
	2. Cattle Breeding Farm, Bankapur.	240	Do.	Do.	Amrit Mahal.	39	39	37	25
	3. Government Central Poultry Farm, Kirkee.	4	Do.	Do.	White Leghorn.	..	..	..	..
					White Wyandotte.	..	..	..	..
					Rhode Island Red.	..	..	..	..
					Australorp.	..	..	..	..
					Asseel	..	..	..	..
					Well Summer.	..	..	..	..
	4. Imperial Council of Agricultural Research, Poultry Research Scheme, Kirkee Centre.	2	Do.	Do.	White Leghorn.	..	..	..	..
					Rhode Island Red.	..	..	..	..
					Black Minorca.	..	..	..	..
					Light Sussex.	..	..	..	..
					Australorp.	..	..	..	..
					Cross-breed—				
					White Leghorn.	..	..	..	..
					Rhode Island Red.	..	..	..	..
					Naked Neck.	..	..	..	..
					Chittagong.	..	..	..	..
					Duck Class.—				
					Khaki Campbell. Indian Runner.	..	..	..	..

DIX XV—*contd.*

***farms in India during 1938-39*—contd.**

On the farm on 30th June 1939							
Sheep and Goats	Donkeys	Horses and Mules	Camels	Poultry	Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
11	12	13	14	15	16	17	18
						Rs.	Rs.
..	..	..	..	..	Bulls . . 2	..	..
..	..	..	..	..	Rams . . *Nil.* Poultry . . 17	..	..
..	..	..	..	8	Eggs . . 206	3,043	12,398
..	..	..	..	..	24 Bulls . .	12,374	22,528
..	..	..	..	..	11 Bulls . .	2,162	10,976
..	..	..	..	140	....	..	..
..	..	..	..	16	....	..	..
..	..	..	..	76	104 Stud purposes	2,888	10,303
..	..	..	..	82 1	406 Birds . .		
..	..	..	..	7	940 Setting Eggs .		
				322			
..	..	..	..	100	....		
..	..	..	..	78	....		
..	..	..	..	57	288 Birds . .		
..	..	..	..	28 1	292 Setting Eggs .	2,783	7,179
..	..	..	..	78			
..	..	..	..	41	....		
..	..	..	..	11	....		
..	..	..	..	25	....		
..	..	..	..	29	....		
..	..	..	..	448			

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
					Breed	Cattle (including buffaloes)			
						Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Bombay	5. Imperial Council of Agricultural Research, Poultry Research Scheme, Vadala Centre, District Ahmednagar.	..	Rev. R. W. Fairbank.	Livestock Expert to Govt., B. P. Poona.	White Leghorn	..	..	..	..
					Black Minorcas.	..	..	..	..
	6. Imperial Council of Agricultural Research, Poultry Research Scheme, Ankleshwar Centre, District Broach.	..	Mr. D. J. Lichtey.	Do.	Rhode Island Red. White Leghorn. Country Selection.	..	..	..	..
	7. Sheep Breeding Farm, Poona.	289	..	..	Deccani Merino.	..	..	..	..
	8. Agricultural College Dairy, Kirkee, District Poona.	362	Manager.	Prof. of Agri., Agril. College, Poona.	Sindhi cows and Surti and Murrah buffaloes.	7	117	77	72
	9. Surat Farm, District Surat.	260	Supdt.	Dy. Dir. of Agri., Gujarat, Surat.	Kankrej.	6	18	1	33
	10. Cattle Breeding Farm, Tegur, District *Dharwar*.	370	Agril. Sub-overseer-in-Charge.	Dy. Dir. of Agri., S. D., Dharwar.	Cross Amrit Mahal.	50*	42	..	49
Bengal	Cattle Breeding Section, Dacca Farm.	3 *Fodder* supplied from Dacca Farm.	Livestock Expert to the *Govt. of* Bengal.	Officer-in-Charge, Cattle *Breeding* Section, Dacca Farm.	Sindhi	9	10	12	2
					Hariana	5	9	6	3
					Sindhi cross.	3	3	3	2
					Hariana cross.	7	21	16	11
			..	..	Murrah Buffalo.	7	11	14	6
	Poultry Section, Dacca Farm.	..	Livestock Expert, Bengal Farm.	Poultry Section, Dacca Farm.	..	..	..	..	..
United Provinces	Madhurikund . .	1396	Mr. Babu Ram Singh.	Dy. Director of Agriculture, Incharge, Cattle Breeding *Operations*, United Provinces, Jhansi.	Hissar	286	168	23	266
					Murrah	16	67	..	99
					Sahiwal	4	4	..	4
					Tharparkar.	2	..	..	..

* Includes 6 bullocks.

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	12	13	14	15	16	17	18
						Rs.	Rs.
..	..	..	..	21	16 Birds . .		
..	..	..	..	4			
..	..	..	..	25			
..	..	..	..	75	42 Birds . .		
..	..	..	..	82	1,107 Eggs . .		
..	..	..	..	61	....	..	..
				218			
50	..	..	..	..	....	762	12,042
15							
Nil	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	47,495	37,202
..	..	..	..	..	6 Bulls . .	4,098	3,468
8	..	..	.	..	3 Bulls . . .	846	3,185
..	..	..	..	..	....	6,109	21,977
..	..	..	..	..	Bulls 20 (free) .	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	546	Eggs . . 2,576 Birds . . 352	560	5,949
..	..	2	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	372	19,648	53,945

APPEN

Cattle and other livestock

Province or state.	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
						Cattle (including buffaloes)			
					Breed	Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
United Provinces	Manjhra . .	551	Mr Ramji Lal.	..	Hissar	16	..	..	..
					Sahiwal	52	47	30	114
					Ponwar	12	..	..	..
					Murrah	1	..	..	..
					Tharparkar.	..	2	..	..
	Bharari . . .	2,241	Mr Vishwa Ram Singh.	Dy. Director of Agriculture, Incharge, Cattle Breeding Operations, United Provinces, Jhansi.	Hissar	75	110	30	154
					Murrah	37	57	28	81
					Kenkatha	27	..	..	..
	Hempur . .	7,348	Mr Padam Singh.	Do.	Kherigarh.	60	240	32	265
					Ponwar	25	400	59	457
	Quarantine Station, Bainpur-Artauni, District Agra.	..	Mr Raghubir Singh.	Do.	Hissar	98	..	..	..
					Murrah	3	..	..	..
	Government Stallion Depot, Moradabad.	7	Veterinary Inspector.	Director, Veterinary Services.	..	..	..	..	..
Punjab . .	Poultry Farm, Gurdaspur.	6½	Poultry Expert, Gurdaspur.	Deputy Director of Agriculture, Gurdaspur.	..	..	..	..	..
	Agricultural College Dairy Farm, Lyallpur.	36	Manager	Professor of Agriculture, Lyallpur.	Montgomery	2	25	10	15
					Buffaloes (Nili Bar).	1	10	..	10
	Punjab Agricultural College Poultry Farm, Lyallpur.	1	Do.	Do.	..	..	..	..	..

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	*12*	*13*	*14*	*15*	*16*	*17*	*18*
						Rs.	Rs.
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	137	2,220	14,095*
..	..	1	..	..	....	..	..
..	..	..	..	..	....	..	..
..	..	..	..	..	177	19,502	38,401
..	..	..	..	..	....	..	..
..	..	..	..	..	18	2,664	5,694
..	..	..	..	..	339	..	15,235†
..	3	10	..	..	Donkeys . *Nil* Horses . 14	232	24,254
..	..	..	..	White Leghorn 133 Black Minorca 62 Rhode Island Red. 129 Light Sussex 72 *Asil* . 211 Chittagong 71 *Improved* Indigenous. 204 Mongrel . . 158 1,040	.... Eggs . . 1,805 *Poultry* . 151	153	15,600 .. ..
					Bull calves of cows 4	13,829	13,042
..	..	..	..	..	..	..	..
..	-	..	..	White Leghorn [illegible]7 Black Minorca 35 Light Sussex 7 Australorp 22 Rhode Island Red. 53 Well *Summer* 1 Desi 34 210	.... Eggs . 2,099 Poultry . 33	679	616 .. ..

* Farm has been closed from September 1939

† Nearly started from September 1938

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
					Breed	Cattle (including buffaloes)			
						Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Punjab	Dairy Farm, Rawalpindi.	..	Manager	Deputy Director of Agriculture, Rawalpindi.	Dhanni	1	8	1	13
	Poultry Farm, Rawalpindi.	..	Do.	Do.	..	..	..	..	..
	Poultry Farm, Montgomery.	1	Do.	Deputy Director of Agriculture, Montgomery.	..	..	..	..	..
	Poultry Farm, Jullundur.	..	Do.	Deputy Director of Agriculture, Jullundur.	..	..	..	..	..
	Agricultural Farm, Jullundur.	..	Do.	Do.	..	..	..	..	..
	Government Cattle Farm, Hissar.	39,829	Supdt., Govt. Cattle Farm, Hissar.	Director, Veterinary Services, Punjab, Lahore.	Hissar breed.	1,671	3,080	1,284	313
					Merino sheep.	..	..	..	..
					Hissar sheep.	..	..	..	..
					Bikanir sheep.	..	..	..	..
					Lohi sheep.	..	..	..	..
					Goats (Betal).	..	..	..	..

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	12	13	14	15	16	17	18
						Rs.	Rs.
						1,106	1,218
..	..	..	..	White Leghorn 75 Black Minorca 15 Rhode Island Red. 20 Light Sussex 8 Desi 94 212	Eggs . . 1,932	1,048	1,191
..	..	..	..	White Leghorn 16 Black Minorca 26 Light Sussex 25 Desi Mongrel 8 Rhode Island Red. 20 95	Eggs . . 814 Poultry . 20	428	878
..	..	..	..	White Leghorn 33 Rhode Island Red. 24 Light Sussex 29 Black Minorca 12 Desi 36 Asil 6 140	Eggs . . 649 Poultry . 59	.. 354	.. 647
Sheep 45 Rams 3 Young Stock. 36 84	..	..	..	..	....	126	196
..	135	Mares =17	12	..	Bulls . . 581 Donkey stallions 13		
1		Mules =1					
1,119	..	..	..	..	Arab stallions 3	2,82,911	4,94,914
922	..	..	..	..	Rams . . 200		
274	..	..	..	..	Bucks . . 46		
292	..	..	..	..	....		

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
					Breed	Cattle (including buffaloes)			
						Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Punjab	Jehangirabad Cattle Farm, Multan.	4,189	Deputy Supdt., Civil Vety. Deptt., In-charge, Grantee Farms, Montgomery.	Director, Veterinary Services, Punjab, Lahore.	Sahiwal	1,115	445	102	338
	Allahabad Cattle Farm, Multan.	4,056	Do.	Do.	Do.	518	250	178	142
	Montgomery Dairy Farm, Montgomery.	485	Do.	Do.	Ravi and Nili Buffaloes.	2	32	30	12
					Sahiwal Cows.	2	120	84	31
	Qadirabad Cattle Farm, Montgomery.	1,011	Do.	Do.	Hissar	14	125	48	166
	Bahadur-Nagar Buffalo Farm, Montgomery.	3,049	Do.	Do.	Ravi and Nili Buffaloes.	6	300	102	77
	Sher-Garh Grants	5,462	Do.	Do.	Sahiwal	8	425	258	488
Bihar	Govt Cattle Farm	650	Manager	Principal, Bihar Veterinary College.	Tharparkar.	44	144	116	163
					Cross-breed.	12	30	2	31
	Government Experimental Farm, Kanke.	370	Farm Manager, Kanke.	Dy. Dir. of Agriculture, C. N. R., Kanke.	Tharparkar.	4	38	31	37
					Shahiwal	3	51	36	42
					Cross	..	3	..	8
					White Leghorn.	..	.	..	..
	Government Experimental Farm, Pusa.	742	Assistant Director of Agriculture, Pusa.	Deputy Dir. of Agri., Pusa.	Hansi } Hissar }	2	22	2	50
					Cross	1	8	2	21
					Tharparkar.	..	1	..	1
					Shahabad	..	2	..	2
	Sepaya	379	Farm Manager.	Asstt. Dir. of Agri.	Murrah.	38	32	42	12

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	12	13	14	15	16	17	18
						Rs.	Rs.
..	..	..	..	..	25	36.000	32,000
..	..	..	..	..	26	36,054	34,104
..	..	..	..	..	*Nil*	15,000	12,097
..	..	..	..	..	*Nil*		
..	..	..	..	..	19	15,809	14,905
..	..	..	..	..	1	44,034	73,770
..	..	..	..	..	....	..	..
66	..	(*a*) 1	..	..	*Nil*	53,566	68,901
..	..	..	..	..	*Nil*		
..	..	..	..	..	*Nil*	[illegible]	33,3[illegible]
..	..	..	..	..	*Nil*		
..	..	..	..	254	Poultry birds 143 Fertile eggs . 403		
..	..	..	..				
..	..	..	..	*Nil*	1	40,781	39,440
..	..	..	..				
..	..	..	..				
..	..	..	..	..	....	21,546	19,642

(*a*) For milk float

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	Total number of livestock: Breed	Cattle (including buffaloes): Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Central Provinces and Berar	Tolenkhery	320	Superintendent.	Extra Assistant Director, Animal Husbandry.	Sahiwal (cow breed).	31	36	35	16
					Murrah (Buff. breed).	16	24	21	6
	Bod.	3,093	Do.	Do.	Cross-breed.	*73	114	98	57
	Pakaria	2,014	Do.	Do.	Malvi cross.	29	54	48	47
	Garhi	1,627	Do.	Do.	*Gaolao*	85	102	85	54
					Murrah crosses.	14	6	10	3
	Dewal.	3,614	Do.	Do.	Malvi cows. Murrah Buff. cows.	The Farm was opened in 1938-39.			
	Dhar Farm	200	Manager	Do.	..	..	..	..	..
Assam	Upper Shillong Farm	522	Farm Manager.	Deputy Director of Agriculture, Livestock.	Fresian	1	..	..	..
					Cross-breed.	1	29	15	21
	Khanapara Farm	206	Do.	Do.	Scinde	2	7	4	11
					Scinde grades.	3	26	18	64
					Assamese	..	..	..	..
	Sylhet Farm	226	Do.	Do.	Scinde	4	13	8	9
					Scinde grades.	3	22	22	28
					Local	..	..	..	..
	Jorhat Farm (Cattle Section).	..	Do.	Do.	Jorhat Grey.	..	17	..	16
					Scinde	2	..	15	..
					Hariana x Local grades.	12	..	..	14

* Not for breeding purposes

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939							
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry	Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
11	12	13	14	15	16	17	18
						Rs.	Rs.
..	..	..	..	..	20 Cow bulls, Sahiwal 2 Buff. bulls, Murrah	20,827	26,944
..	..	..		353 birds .	107 Cockerels. 824 eggs for hatching.		
..	..	..	..	..	1 bull . . .	1,086	11,150
..	..	..	..	..	8 bulls . . .	947	7,480
..	..	..	..	..	18 bulls . .	5,102	8,109
..	..	..	..	..	....		
..	..	..	..	..	....	84	31,820
..	..	..	..	..	....	*Nil*	3,970
Bikanir 57 Bikanir × Hissardale 38	.. ..	13 ..	.. ..	White Leghorn 50 Rhode Island Red. 48 Crosses . 19	Bulls . . 3 Rams . . 16 Poultry . 54 Eggs . . 8,783	18,386	27,386
Jamnapuri 4 Cross 30 Local 4	.. ..	.. ..	.. ..	White Leghorn 21 Khaki Campbell Ducks and Crosses. 32	Bulls . . 7 Poultry . *Nil* Eggs . . 75 Goats . . 5	3,543	17,253
..	..	..	..	Khaki Campbell Ducks and Crosses. 24	Bulls . . *Nil* Ducks . . 7	4,073	17,598
..	..	..	..	..	. .		
..	..	..	..	Local . 7 Rhode Island Red. 32	Bulls . . 17 Poultry . 15	..	..
..	..	..	..	..	....		
..	..	..	..	..	....		

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
					Breed	Cattle (including buffaloes)			
						Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Orissa	Cuttack Farm	150	Dy. Director of Agriculture.	Director of Development.	Hariana	1	24	..	10
					Cross-bred Local Kherry.	..	..	..	3
					Cross-bred.	..	..	..	..
Sind	Government Fruit Farm, Mirpurkhas.	..	Horticulturist in Sind.	Director of Agriculture, Sind.	..	..	..	..	..
	Government Aux. Farm, Shahdadkot.	212	Manager	Dy. Director of Agriculture, Right Bank.	Bhagnari	26	..	..	..
	Government Seed Farm, Mirpurkhas.	192	Cotton Breeder and Officer-in Charge.	Botanist, Agricultural Research Station, Sakrand.	Thari	86	36	23	22
	W. C. Farm, Malir	800	Manager	Livestock Officer in Sind.	Red Sindhi.	9	29	18	37
Hyderabad	Government Cattle Breeding Farm and Dairy, Himayatsagar, Hyderabad.	464	Superintendent.	Director, Veterinary Department.	Krishna Valley.	8	58	66	77
					Malvi	2	48	57	48
					Murrah Buff.	1	6	10	6

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939							
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry	Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
11	12	13	14	15	16	17	18
						Rs.	Rs.
..	..	..	..	White Leghorn Cock. 12 Hen . 19	75 Eggs, and 18 units of birds—cock 18, hen 108 were distributed free of cost for improvement of poultry.	1,978	3,490
30 ewes	..	..	..	White Leghorn × Chittagong Chickens . 57 Chittagong cock . 4 Chittagong hen . . 4 Turkey cock . 1 Turkey hen . 3 Gander . . 2 Goose . . 1 Cross-bred Cockerels . 13 Crossbred hen 14			
..	..	..	..	White Leghorn Adult 20 hens. White Leghorn Cocks . 4 White Leghorn Cockerels 13 White Leghorn Pullets . 24 Half Bud hens 8	White Leghorn Hens & Poultry. 46 White Leghorn Cocks & Cockerels. 45 91	249	327
				Desi hens . 5 White Leghorn Chickens 69 143	Breeding eggs 305	..	..
..	..	..	..	..	Bulls . . 25	130	1,352
..	..	..	..	..	Bulls . . 68	2,897	18,990
..	..	..	..	..	Bulls . . 6	867	4,057
..	..	..	..	..	....		
..	..	..	..	..	7 Malvi bulls . .	7,840	50,910
..	..	..	..	..	....		

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	Breed	TOTAL NUMBER OF LIVESTOCK — Cattle (including buffaloes) — Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Hyderabad	Cattle Breeding Farm, Hingoli.	..	Cattle Section Officer.	Assistant Director, Stud Farm, Hingoli.	Deoni	20	47	34	11 female stock under one year. 9 male stock under one year. 28 male stock above one year.
	Poultry Farm, Himayatsagar.	..	Fieldman	Deputy Director of Agriculture, Himayatsagar.	Australorp.	..	..	..	..
					Black Minorca.	..	..	..	..
					White Leghorn.	..	..	..	..
					Rhode Island Red.	..	..	..	..
					Light Sussex.	..	..	..	..
					Hyderabad Aseel.	..	..	..	..
					Selected	..	..	..	..
					Country chickens (all breed).	..	..	..	..
	Poultry Farm, Parbhani.	..	Farm Supdt., Parbhani.	Dy. Director of Agriculture, Parbhani.	Rhode Island Red.	..	..	..	..
					Chickens	..	..	..	..
	Poultry Farm, Rural Development Centre, Pattancheru.	..	Superintendent.	Director of Agriculture, Hyderabad.	..	..	..	..	..
Mysore	Cattle Breeding Station, Ajjampur.	1,285	Manager	Livestock Expert in Mysore, Bangalore.	Amrit Mahal.	100	166	79	152
					Cross-bred.	..	..	..	..

DIX XV—*contd.*

farms in India during 1938-39—contd.

On the farm on 30th June 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	12	13	14	15	16	17	18
						Rs.	Rs.
14 sheep	..	..	..	..	17 drafted as bulls 4 drafted as rams.	..	..
..	..	..	..	18	....	..	..
..	..	..	..	9	....	..	..
..	..	..	..	21	....	..	..
..	..	..	..	18	....	..	..
..	..	..	..	8	....	..	..
..	..	..	..	10	Birds 58, Eggs 3,334	..	..
..	..	..	..	22	....	..	..
..	..	..	..	41	....	..	..
..	..	..	..	15	....	..	..
..	..	..	..	5	Birds 5. Eggs 420	..	..
..	..	..	..	218	Birds 194. Eggs. 3,855	..	..
..	..	..	..		Bulls . . 17 Bull Calves . 59	17,956	28,762
117	45 White Leghorn.	..	..	..	Poultry . 45 Rams . . 17 Eggs . . 165	814 1,597	488 2,798

APPEN

Cattle and other livestock

Province or state	Name of farm	Area in acres	Officer in immediate charge	Supervising Officer	TOTAL NUMBER OF LIVESTOCK				
					Breed	Cattle (including buffaloes)			
						Bulls	Cows	Heifers	Calves
1	2	3	4	5	6	7	8	9	10
Mysore	Cattle Breeding Sub-Station, Basur.	5,020	Asst. Manager.	Livestock Expert in Mysore, Bangalore.	Amrith Mahal Breed.	49	113	257	31
	Hebbal Farm, Bangalore.	8	Vety. Inspector.	Do.	Do.	5	..	..	7
					Hallikar	1	20	12	7
	Yellachihally Sheep Farm.	429	Agri. Inspector.	Do.	Local	..	..	..	..
	Nagenahally Poultry Farm.	..	Do.	Do.	..	..	..	..	..
	Closepet Rural Welfare Centre (Poultry).		Poultry Inspector.	Do.	*Newly opened in the year 1938-39.*				
	Hassan Poultry Unit	..	Veterinary Inspector.	Do.	..	..	..	..	..
Cochin	Government Central Farm, Ollukara.	420	Manager, Government Central Farm.	Director of Agriculture.	Ongole	15(*a*)	11	8	14
					Sindhi	5(*b*)	10	5	15
					Polachi	1	2	4	1
					Cochin	1	1	..	1
					English Cross breed.	1	..	..	..
					Buffaloes	8(*c*)	2	1	3
Jammu and Kashmir	Hakkal Bagh Farm	25	Cattle Breeding Manager, Jammu.	Veterinary Inspector, Jammu.	*Note.*—Two Cattle Breeding Farms have been started by the close of October 1939.				
	Shaltang Farm	24	Cattle Breeding Manager, Kashmir.	Veterinary Inspector, Kashmir.	..	..	..	..	..

(*a*) Includes 11 working animals.
(*b*) ,, 1 ,, ,,
(*c*) ,, 7 ,, ,,

DIX XV—*concld.*

farms in India during 1938-39

ON THE FARM ON 30TH JUNE 1939					Issue of bulls, stallions, bucks, rams, etc., for stud purposes and number of eggs and poultry issued for poultry improvement during 1938-39	Receipts for 1938-39	Expenditure for 1938-39
Sheep and goats	Donkeys	Horses and mules	Camels	Poultry			
11	12	13	14	15	16	17	18
						Rs.	Rs.
229	..	..	..	..	....	..	..
					Sales.		
.. 65	.. ..	.. ..	.. ..	White Leghorn 278 Rhode Island Red. 56 Black Minorca 74 Desi . . 23	Poultry 785 Rams 1 Eggs 2,988	Dairy 2,407 Sheep 900 Poultry 7,854	4,978 5,534 6,109
173	..	..	..	Rhode Island Red. 22	Poultry 50 Rams 4	Sheep 2,227 Poultry 184	3,161 79
..	..	..	..	Rhode Island Red. 151	Poultry 64 Eggs 580	Poultry 1,432	841
..	..	..	..	White Leghorn 44	Poultry 450 Eggs 171	447	845
..	..	..	..	White Leghorn 33	Poultry 1 Eggs 727	335	262
..	..	..	..	..	....	5,185	6,524
..	..	..	..	..	Previously purchased 30 bulls (Dhanni and Scindi) and recently purchased by the close of the last financial year 34 bulls and 50 cows (bot . Dhanni and Scindi) were at work by the close of the last year. Besides there were 7 stallions and 3 donkeys also at work during the year under report.	53	28,726

APPENDIX XVI (A)

List of Research Schemes of the Imperial Council of Agricultural Research completed up to 31st March 1939

1. *General Agricultural Schemes*

1. Grant to Dr K. C. Mehta for—
   (a) Investigation of rusts of wheat and barley.
   (b) Investigation into the physiologic forms of wheat rusts.
   (c) Giving some relief from a part of his duties at the College.
2. Appointment of Hemp Marketing Officer.
3. Investigation into the vitamin contents of mangoes.
4. Professor Parija's scheme of water-hyacinth.
5. Dr A. N. Puri's scheme of standardization of physico-chemical single value measurements most suitable for Indian soils.
6. Dr Bhatnagar's scheme on (a) effects of ions on plant growth and (b) physico-chemical properties and fertility of soil.
7. Professor Dastur's scheme of rice physiology.
8. Dr Chaudhri's scheme for investigations on the wither tip of citrus trees.
9. Grants to provinces for collecting data on manurial experiments conducted in the past.
10. Exhibits for World's Grain Exhibition and Conference.
11. Distribution of sodium fluosilicate.
12. Experimental consignment of mangoes to the Empire Marketing Board.
13. Cost of exhibits in connection with commercial samples room of the High Commissioner's Office.
14. Grant to Burma Shell Oil Storage and Distributing Co., Bombay, for tractor operating costings.
15. Enquiry into supply of coconut products in India.
16. Award of a prize for a bone-crusher worked by (a) animal power and (b) mechanical power.
17. Training of an officer in the gas storage of fruits and vegetables.
18. Survey of various fruit growing tracts in Baluchistan to determine the distribution and status as pest of the Codling Moth and *Spilonata Ocellana*.
19. Professor Seth's scheme for investigating an electric method of hygrometry.
20. Financial assistance to the Oil Technological Section of the Harcourt Butler Technological Institute, Cawnpore.
21. Enquiry into production of cloves in India.
22. Gangai pest of rice.
23. Wheat milling and baking laboratory, Lyallpur.
24. Chemistry of malting *cholam*.
25. Madras potato scheme.
26. Tobacco cooperative flue-curing experiments.
27. Investigation of Indian fish poisons and other forest products for their insecticidal properties.
28. Cinchona enquiry.
29. Central Locust Bureau.

2. *Sugar Schemes*

1. Deputation of a Chemist to Bhopal to test Khan Bahadur Hadi's process of manufacturing sugar by open pan method.
2. Hadi's commercial test at Bilari under L. Har Sahai Gupta.
3. Bengal scheme for sugarcane crushing and *gur* boiling.
4. Deputation of Sugar Technologist to Europe and America.

5-7. Lump-sum grants to the United Provinces, Bihar and Orissa and the Punjab Governments in designing a satisfactory small power sugarcane crushing mill.

8. Grant to the Sugar Section of the Harcourt Butler Technological Institute, Cawnpore.
9. Investigation into the production of *khandsari* sugar in the United Provinces.
10. Bihar *khandsari* scheme.

11-14. Sugar Technologist—
   (a) Main Office.
   (b) Sugar Cable Service.
   (c) Construction and testing of improved juice-boiling *bel*.
   (d) Indian Sugar Trade Information Service.

15. Grant to Sugar Demonstration Section of the United Provinces Industrial and Agricultural Exhibition.
16. Deputation of Mr P. V. Isaac to America, Porto Rico, etc. in connection with research on insect pests of sugarcane and representation at the Fourth Imperial Entomological Conference.
17. Sugarcane beetle scheme, Burma.
18. Hyderabad sugar scheme.
19. Economic enquiry into the cost of production of crops.

3. *Animal Husbandry Schemes*

1. Testing of Drug Plasmoquine.
2. Appointment of a Statistician for the compilation of certain statistics relating to feeding scales, etc. in Military Dairies.
3. Investigation of the measures of control in existence for the prevention of adulteration of milk and other dairy products.
4. Training of Mr H. C. Varma in the preparation of skimmed milk and dried milk powder.
5. Punjab apiculture scheme regarding the training of an Agricultural Assistant in apiculture abroad.
6. All-India legislation for the control of animal diseases.
7. Investigation into most suitable methods of combating different types of parasitic infection in ruminants in the field.
8. Investigation regarding vaccination of cattle against rinderpest in the Central Provinces.
9. Village enquiry regarding cattle and the production and consumption of milk.
10. Establishment of pedigree herd books.

APPENDIX XVI (B)

List of Research Schemes of the Imperial Council of Agricultural Research in operation on the 31st March 1939

General Agricultural Schemes

A. Rice—
1. Botanical sub-station.
2. Co-ordinated scheme of rice research in provinces.
3. Extension of work on 'Quality' in crops at the Indian Institute of Science.

B. Wheat—
4. Investigation into rusts of wheat and barley.
5. Scheme for the production of strains of rust-resistant wheats.
6. Wheat rust research scheme, Bombay and Central provinces.

C. Other cereals (Barley, Jowar)—
7. Scheme regarding malting and brewing qualities of barleys in the United Provinces, Punjab, Bihar and Orissa.
8. Research into the *Striga* attack on *jowar*.

D. Fruit—
9. Bombay cold storage fruit scheme.
10. Baluchistan fruit-canning and preserving scheme.
11. Scheme regarding the gas storage of fruits and vegetables.
12. Fruit and vegetable research schemes in Madras, Bengal, Punjab, United Provinces, Bihar, Orissa, Central Provinces, Assam, North-West Frontier Province, Hyderabad and Mysore.
13. Entomological Survey in the Punjab and North-West Frontier Province.
14. *San José scale survey scheme, Kashmir.*

E. Fibres—
15. Investigation into the method of extraction of flax fibres in Bengal.
16. Investigation into sunn-hemp cultivation in Madras, Bombay, Central Provinces and Bihar.
17. Improvement of castor crop by H. E. H. the Nizam's Government.
18. Linseed research in Bengal.

F. Oil-seeds—
19. Linseed research in the Central Provinces.
20. Punjab rape and mustard research scheme.
21. Groundnut research in Madras.
22. Supply of decorticated cotton-seed cake for educative propaganda.
23. Research on coconuts in the Madras Province.
24. Investigation of the 'Root' disease of the Coconut Palm in South India.

G. Coffee—
25. Mysore coffee research scheme.

H. Potatoes—
26. Potato breeding research in Northern India.

I. Tobacco
27. Research on cigarette tobacco at Guntur.
28. Training of officers in tobacco cultivation and research.

J. Pan *cultivation*—
29. Research on *Pan* cultivation in the Central Provinces.

K. Soil studies—
30. Grant to Dacca University for agricultural research.
31. Professor Mukerjee's scheme of research into properties of colloid soil constituents.
32. Appointment of a physical assistant on the staff of the Agricultural Chemist, Bengal.
33. Investigation into the organic constituents of Indian Soils by Professor J. C. Ghosh.
34. Preparation of cheap synthetic manure from town refuse and waste materials.
35. Dr Dhar's scheme regarding nitrogen fixation in soils.
36. Research on the water requirements of the crops in the Punjab.
37. Research on coastal soils.

L. Plant physiology—
38. Research on plant physiology by Dr Boshi Sen.
39. Research in the physiology of cane and wheat at the Benares Hindu University.

M. Protection of crops—
(*a*) Locusts.

40. Punjab locust research scheme.
41. Appointment of Special Locust Research Staff with headquarters at Karachi.
(b) Plant diseases.
42. Investigation of virus diseases of plants.

N. Dry farming—
43. Research Schemes in Madras, Bombay, Punjab and Hyderabad.

O. Insecticides and medicinal plants—
44. Scheme regarding the systematic cultivation of medicinal plants and study of food poisons by Col. Chopra.

P. Miscellaneous—
45. Scheme regarding Statistical Studies and experimental errors in field trials by Professor P. C. Mahalanobis.
46. Research on Agricultural Meteorology.
47. Statistical section of the Bureau of Agricultural Intelligence.
48. Research in Agricultural Economics at the Gokhale Institute of Politics and Economics.
49. Scheme regarding eradication of *kans* grass.

Animal Husbandry Schemes

A. Animal Pests and Diseases and Cure—
1. Appointment of Veterinary Investigation Officers in Provinces.
2. Investigation of Johne's disease among cattle in Mysore.
3. Research on Warble flies.
4. Investigation of tuberculosis and Johne's disease among animals at the Imperial Veterinary Research Institute, Mukteswar.
5. Investigation into contagious abortion in cattle, goats and sheep.
6. United Provinces Helminthiasis Scheme.
7. Appointment of a Systematic Protozoologist at the Imperial Veterinary Research Institute.
8. Inquiry into the Helminthiasis of cattle in the Madras Province.
9. Research on the control of ticks in the Bombay Province.
10. Research into the indigenous drugs of India with special reference to their toxicology.
11. Scheme regarding study of indigenous veterinary methods.

B. Dairying—
12. Research on the composition of milk.
13. Research at the Anand creamery into the manufacture of products and by-products of milk.
14. Grant for the continuance of the Indian Dairy Diploma Course.
15. Scheme regarding the formation of milk-recording Societies.

C. Cattle feeding—
16. Practical research into feeding of cattle on departmental farms.
17. Scheme regarding feeding of minerals to cattle in Bihar and Orissa.
18. Scheme for determining the feeding values of certain food grains, oil-seeds and cakes for working bullocks and dairy cattle.

D. Goat and sheep-breeding—
19. Dr Slater's scheme of goat-breeding.
20. Indigenous sheep-breeding scheme, Punjab.
21. Bombay sheep-breeding scheme.
22. Madras sheep-breeding scheme.
23. Punjab goat-breeding scheme.
24. Angora goat-breeding scheme.

E. Animal nutrition—
25. Appointment of a physiological chemist to study animal nutrition at Dacca.
26. Extension of work on animal nutrition in the Madras Province.
27. Assam animal nutrition scheme.

F. Poultry—
28. Poultry husbandry scheme, Bombay.
29. Research in the improvement of Poultry for table purposes in Northern India.
30. Research into the diseases of Poultry in Bengal (I. V. R. I.).

G. Fish—
31. Research in fresh water fishes in Bengal.

H. Veterinary and Dairy Training and Scholarship—
32. Training of a scholar in animal genetics in the United Kingdom.

I. Animal Husbandry—
33. All-India Animal Husbandry Bureau.

Sugar Research Schemes

A. Testing, Agricultural and Manurial Experiments—
1. Grant to Shahjhanpur Research Station for examination and study of sugarcane seedlings.
2. Bombay-Deccan sugarcane research scheme.
3. Establishment of a sugarcane research station in Bihar and appointment of a Sugarcane Specialist.
4. Scheme for the establishment of a sub-station of the Coimbatore Imperial Sugarcane Station at Karnal.
5. Sugarcane Seedling Testing Station, Dacca.
6. Madras sugarcane research scheme.
7. Sugarcane Research Station, Punjab.
8. Investigation into various problems of Sugar Industry, United Provinces.
9. Extension of Sugarcane work at the Jorhat Experimental Station, Assam.
10. Sugarcane Research in North-West Frontier Province.
11. Scheme regarding manufacture of cattle feed from molasses.
12. Planning of experiments on ratooning of sugarcane in the United Provinces and Bihar.
13. Scheme regarding the reclamation of alkaline and *usar* lands in the United Provinces.

B. Technology, gur-*making, etc.*—
14. Establishment of a Research and Testing Station for the indigenous system of *gur* and sugar manufacture by the Director, Imperial Institute of Sugar Technology.
15. Scheme for a Bureau of Sugar Standards.

C. Sugarcane pests and diseases—
16. Research on mosaic and other cane diseases at Imperial Agriculturel Research Institute, New Delhi.
17. Research on Insect Pests of Sugarcane (Central).
18. Sugarcane Insect Pests Scheme (Provincial).

D. Morphology, Cytology, Cane-breeding and Genetics—
19. Grant to Mysore Darbar for breeding thick canes.
20. Research on the genetics of Sugarcane at the Imperial Cane-breeding Station, Coimbatore.
21. Research on the morphology and anatomy of sugarcane Sorghum hybrids and of the Indian Sugarcane.
22. Research on the chemistry of sugarcane.
23. *Investigation of suitable types of cane for Gujrat.*

E. Marketing survey—
24. Sugar marketing survey scheme.

F. Miscellaneous—
25. Chief Economist and the staff in connection with the Economic Enquiry into the cost of production of crops in the principal sugarcane and cotton tracts in India.
27. Utilization of bagasse for paper and board industry.

Marketing

1. Provincial Marketing Scheme.
2. Cold Storage Scheme.

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